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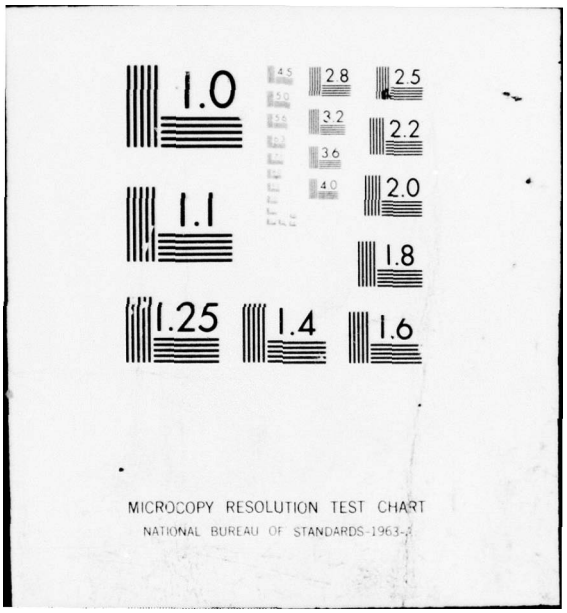
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PREDICTED HF COVERAGE RELIABILITIES FOR THE USCG SSB SMALL CRAFT COMMUNICATION SYSTEM IN THE ALASKAN REGION

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U.S. DEPARTMENT OF COMMERCE
Elliot L. Richardson, Secretary

Betsy Ancker-Johnson, Ph. D.
Assistant Secretary for Science and Technology

OFFICE OF TELECOMMUNICATIONS
John M. Richardson, Acting Director

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OFFICE OF TELECOMMUNICATIONS
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- Conducts research needed in the evaluation and development of telecommunication policy as required by the Office of Telecommunications Policy, pursuant to Executive Order 11556

PREFACE

The study described in this report is one of the several performed for and with the support of the Commandant, U.S. Coast Guard, under a general communications consulting contract (MIPR-2-70099-0-02243). Capt. William T. Adams, Chief, Communications Staff, was the Coast Guard contract monitor. Lt. F. N. Wilder, USCG, was the designated technical monitor.

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PREDICTED HF COVERAGE RELIABILITIES FOR THE USCG SSB SMALL CRAFT COMMUNICATION SYSTEM IN THE ALASKAN REGION

William A. Kissick*

This work presents a study of the HF communication reliability of the high-frequency SSB small craft communication system for the Alaskan waters. Reliabilities are calculated assuming ionospheric propagation from a number of simulated ship positions (SSP's) in the waters bounded by 50° N. to 75° N. and 125° W. to 170° E. to three existing shore stations (San Francisco, Honolulu, Kodiak) on three maritime frequency bands (represented by 4, 6, and 8 MHz). These calculations are used to produce "base" coverage reliability maps for the following conditions: winter or summer, night or day, and high or low solar activity. It has been proposed to add one or two new shore stations at Adak or Barrow or both. The coverage reliability realized by adding either or both of these stations using all three frequencies is calculated. The best two and the best single frequency are then chosen for the added station(s) and the reliabilities are again calculated including either or both of the proposed stations.

Key words: Alaskan waters, communications, HF, merchant vessels, reliability, SSB.

1. INTRODUCTION

The U.S. Coast Guard (USCG) operates the Automated Merchant Vessel Reporting System (AMVER). In this system, ships of many different flags voluntarily send regular radio reports of their position, course, speed, and search and rescue (SAR) capabilities (e.g., whether they have a doctor aboard). These data are then sent to the AMVER center in New York where they are stored on computer. In the event of an emergency at sea, such as a disabled or sinking ship, an ill crewman or passenger, or a plane down, these data can be rapidly retrieved to determine which ships are in the vicinity that can give aid to the stricken vessel or aircraft. These ships and others usually send a weather observation report (METEO) at synoptic hours. These METEO reports are a great help in collecting weather prediction data from the oceanic areas. Many of these AMVER and METEO messages are handled on the HF

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maritime frequencies by USCG radio stations using CW. A single-sideband (SSB) voice communications system would enable an expansion of these services to those ships that are equipped only for voice communications. Further, such an SSB system could be used for coordination of many administrative communication activities between the communication stations and both government and nongovernment vessels: selecting frequencies, establishing radioteletype circuits and arranging phone patches. There are times when such an SSB system would provide contacts to vessels beyond the VHF-FM/2 MHz frequency range as a safety measure.

The geographical region examined in this report represents an extension to the regions covered by a previous study (OT Tech. Memo 74-180, by Roberts and Stonehocker, limited distribution). The analysis techniques, computer programs, and assumptions used herein are similar to those used in TM 74-180; hence it is assumed that the reader is familiar with the work reported in that reference.

A portion of TM 74-180 was devoted to an examination of the Pacific region, which includes three shore stations (San Francisco, Honolulu, and Kodiak). The waters of interest there were defined as that region that lies within approximately 400 nmi (seaward) of: the Pacific coast, the southern coast of Alaska, and the Hawaiian Islands. The geographical region considered by this report is bounded by 50° N. to 75° N. latitude and 125° W. to 170° E. longitude. The above mentioned three Pacific shore stations are again used, and, in addition, two possible new locations are considered. These two locations are at Adak and Barrow (both in Alaska). At all the shore stations, three frequencies, 4, 6, and 8 MHz, are available.

The purpose of this report, then, is twofold. First, a "base" coverage reliability* of the area is obtained using the three existing Pacific shore stations and the three available frequencies. Second, "new" coverage reliabilities gained by establishing a station at Adak or at Barrow or at both locations using all three frequencies is calculated. Then the best two frequencies or the best single frequency is established for each or both added

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*The percentage of days in a month at a specified hour that the required signal-to-noise ratio is equaled or exceeded.

stations, and the coverage reliability is again calculated. The three existing stations will always use all three of the frequencies.

2. ASSUMPTIONS

The basic assumptions that were used in TM 74-180 are duplicated as closely as possible for this report. These are the following:

(1) Two levels of solar activity are used. In terms of the Zurich sunspot number (SSN), these are 10 and 110.

(2) Seasonal and diurnal variations are represented by the four cases: winter night and day, and summer night and day.

(3) The ship-to-shore communication circuit is poorer than the shore-to-ship circuit, so only the former case is modeled.

(4) A shipboard transmitter power of 150 W PEP into a 24 ft (7.3 m) vertical whip will represent a typical installation.

(5) The modem of SSB voice with a required signal-to-noise power density ratio of 49 dB represents the threshold of usable quality (Akima, Ax, and Beery, 1969).

(6) The man-made radio noise at each of the shore stations is classified as "rural" except for Honolulu which is "suburban/rural."

(7) The relative permittivity and conductivity of the ground at all shore stations is assumed representative of good "earth." These are 10.0 and 0.01 mhos/m, respectively. The relative permittivity and the conductivity at each simulated ship position (SSP) are those of sea water, 18.0 and 5.0 mhos/m, respectively.

(8) The receiving antennas at each shore station have a 5 dBi gain at all azimuths, take-off angles and frequencies.

3. ANALYSIS

The same computer programs that were used for the work reported in TM 74-180 are used for this report. Earlier versions of one of these programs were used for the NOAA/USCG National Data Buoy Project (Hatfield and Adams, 1970) and in an AMVER study (OT Tech. Memo. 43, Adams and Hatfield, 1971, limited distribution). This program will compute and store the communication reliability (assuming an ionospheric propagation mode) from each simulated ship position (SSP) to each shore station for each frequency and for each combination of seasonal, diurnal, and solar activity conditions. Figure 1 shows the locations of the SSP's in the region of interest. The output of this program is the basis of all calculations, hence, all maps shown in this report. Different combinations and manipulations of these data are used to form the "base" coverage reliability maps and to form the tables and maps showing the reliabilities obtained by adding either or both of the proposed stations. In forming the "base" coverage reliability maps for the three existing stations, any of these shore stations and any frequency of the three available frequencies may be used; therefore, these reliabilities reflect the use of the most reliable (or "first choice") station/frequency combination. This assumption is also made when one or both of the proposed stations are added.

The choice of the best two frequencies and the best single frequency makes use of the concept of "choice product" (OT Tech. Memo 74-162, Adams and Falcon, limited distribution) to form a weighted average. This technique results in an ordering of the frequencies in terms of how often each was chosen as either first, second, or third choice and with how high an average reliability. The choice product is defined as $R_{nm}\ S_{nm}$, where R_{nm} is the average reliability for frequency m being choice n (that is, the average overall SSP's where frequency m is the nth choice) and S_{nm} is the number of times of that occurrence, independent of the particular station chosen. The weighted average is then expressed as

$$W_m = \sum_{n=1}^{3} R_{nm}\ S_{nm} \quad .$$

The "best" single frequency is the one represented by the maximum W_m. Tables of the "weighted" average, W_m (normalized to the maximum for each set of

conditions), and the frequency m, are listed in the appendix and summarized in table 2 in the next section.

4. RESULTS

Since all aspects of the results (i.e., "base" coverage reliabilities, reliabilities afforded by the proposed stations and "best" frequencies) are dependent upon the seasonal, diurnal, and solar activity conditions, the results are organized into eight groups. These will be delineated by the above mentioned conditions: winter or summer, night or day, and low or high sunspot number. These are listed below in table 1. Figures 2 through 10 present the results for group A: winter, day and low SSN.

The upper map in each figure is the "base" coverage reliability map, which is made under the assumption that all three frequencies are available at the three existing shore stations. The lower map of the first three figures (2, 3, and 4) present the coverage reliabilities associated with the establishment of an additional guard at Adak. In the first of these, figure 2, all three frequencies are considered. The next one, figure 3, is restricted to the best two frequencies for Adak, 6 and 8 MHz, and the last, figure 4, to the best single frequency for Adak, 6 MHz. These frequencies have been determined by using the choice product and weighted average concepts presented in section 3. Also note that the existing stations always use 4, 6, and 8 MHz.

Figures 5 through 7 present the coverage reliabilities assuming the establishment of a guard at Barrow instead of at Adak. For this case the best two frequencies for Barrow were determined to be 6 and 8 MHz and the best single frequency for Barrow to be 6 MHz.

To complete this group, figures 8 through 10 again show the coverage reliabilities; however, it is now assumed that both the Adak and the Barrow guards are established. The best two and the best single frequencies for these two stations are determined to be 6 and 8 MHz, and 8 MHz, respectively.

This format is repeated for group B, C, etc. and tables of station/frequency combinations ordered by weighted average can be found in the appendix for all cases. Table 2 is a summary of the best two and the best single frequency used for each set of conditions and each set of stations.

Table 1. Groups of Seasonal, Diurnal, and Solar Activity Conditions

Group	Figures	SSN	Time	Month
A	2-10	10	2400 GMT 1200 Local (Day)	JAN (Winter)
B	11-19	110		
C	20-28	10	1200 GMT 2400 Local (Night)	
D	29-37	110		
E	38-46	10	2400 GMT 1200 Local (Day)	JUL (Summer)
F	47-55	110		
G	56-64	10	1200 GMT 2400 Local (Night)	
H	65-73	110		

Table 2. Summary of the Best Two and the Best Single Frequency of the Available Three Frequencies for all Station Combinations and Conditions (Frequencies in MHz)

Additional Guards Established at		Adak		Barrow		Adak and Barrow	
Number of Best Frequencies Chosen		2	1	2	1	2	1
Group	A	6,8	6	6,8	6	6,8	8
	B	6,8	8	6,8	8	6,8	8
	C	4,6	4	4,6	4	4,6	4
	D	4,6	4	4,6	4	4,6	4
	E	6,8	8	6,8	8	6,8	8
	F	6,8	8	6,8	8	6,8	8
	G	4,6	4	4,6	4	4,6	4
	H	4,6	6	6,8	6	6,8	8

5. GENERAL CONCLUSIONS

A few observations of a general nature may be stated concerning the results. The "base" coverage reliability maps indicate that, for most conditions, the reliabilities are low in the northern and western regions of the area. During summer or during high solar activity conditions, these regions of low reliability tend to be larger. It is desirable to increase the reliability in these regions by the addition of a station at Adak or at Barrow or at both. If only one of these sites is added (still using all three frequencies), Adak is more desirable during conditions of low solar activity and Barrow during high solar activity. Also, in the summer, the reliabilities tend to be lower, hence the addition of both Adak and Barrow may be necessary to realize high communication reliability over the entire area of interest.

Now, consider using the best pair or the best single frequency, at one or both proposed stations. In general, if one station is added, and the best frequency pair is chosen, the reliabilities are not significantly reduced relative to the case where all three frequencies are used. The use of the best single frequency generally does not reduce the reliabilities significantly, except during winter nights.

6. REFERENCES

Akima, H., G. G. Ax, and W. M. Beery (1969), Required signal-to-noise ratios for HF communication systems; ESSA Tech. Report ERL 131-ITS 92 (US GPO, Washington, D.C. 10402).

Hatfield, D. N., and J. E. Adams (1970), The basis and application of a simulation model for oceanographic data transmission; ESSA Tech. Report ERL 171-ITS 109 (US GPO, Washington, D.C. 10402).

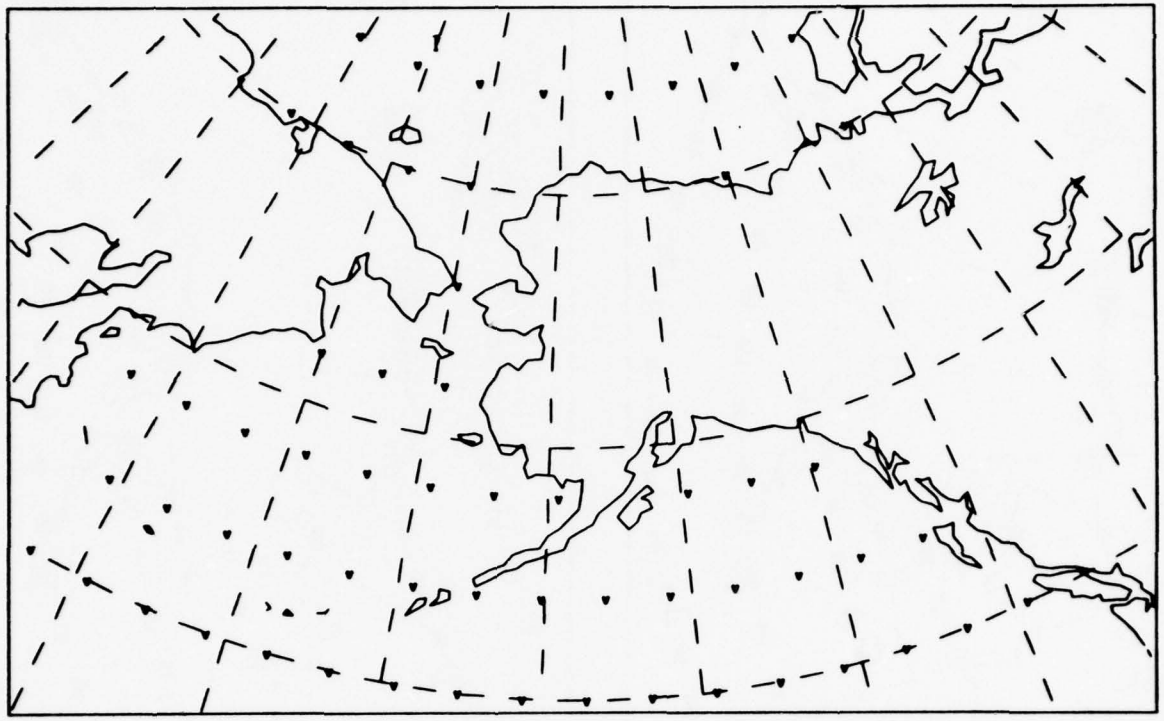

Figure 1. Simulated Ship Positions (SSP's) in the area of this study.

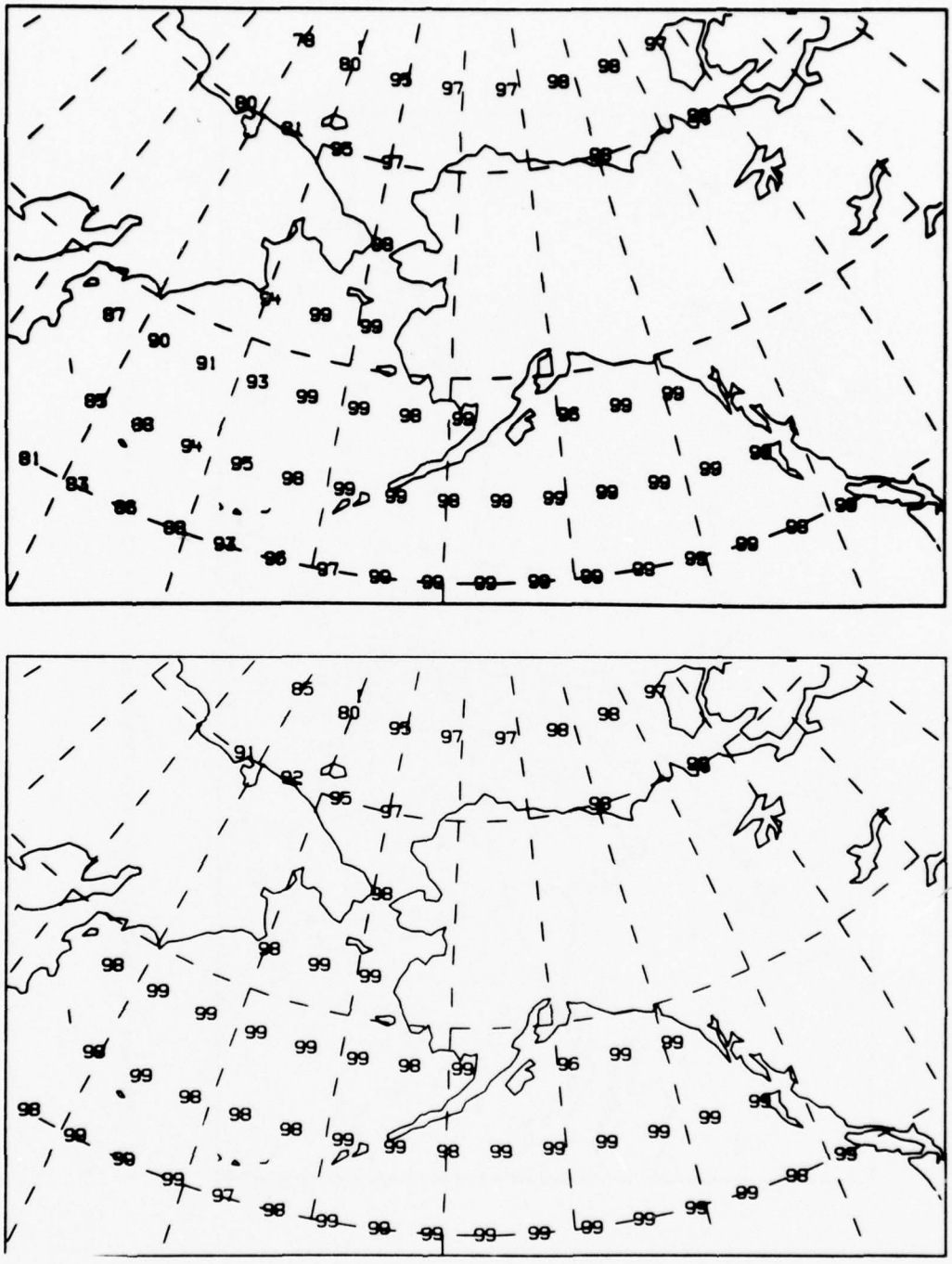

Figure 2. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak, 4, 6, and 8 MHz, winter day and low solar activity.

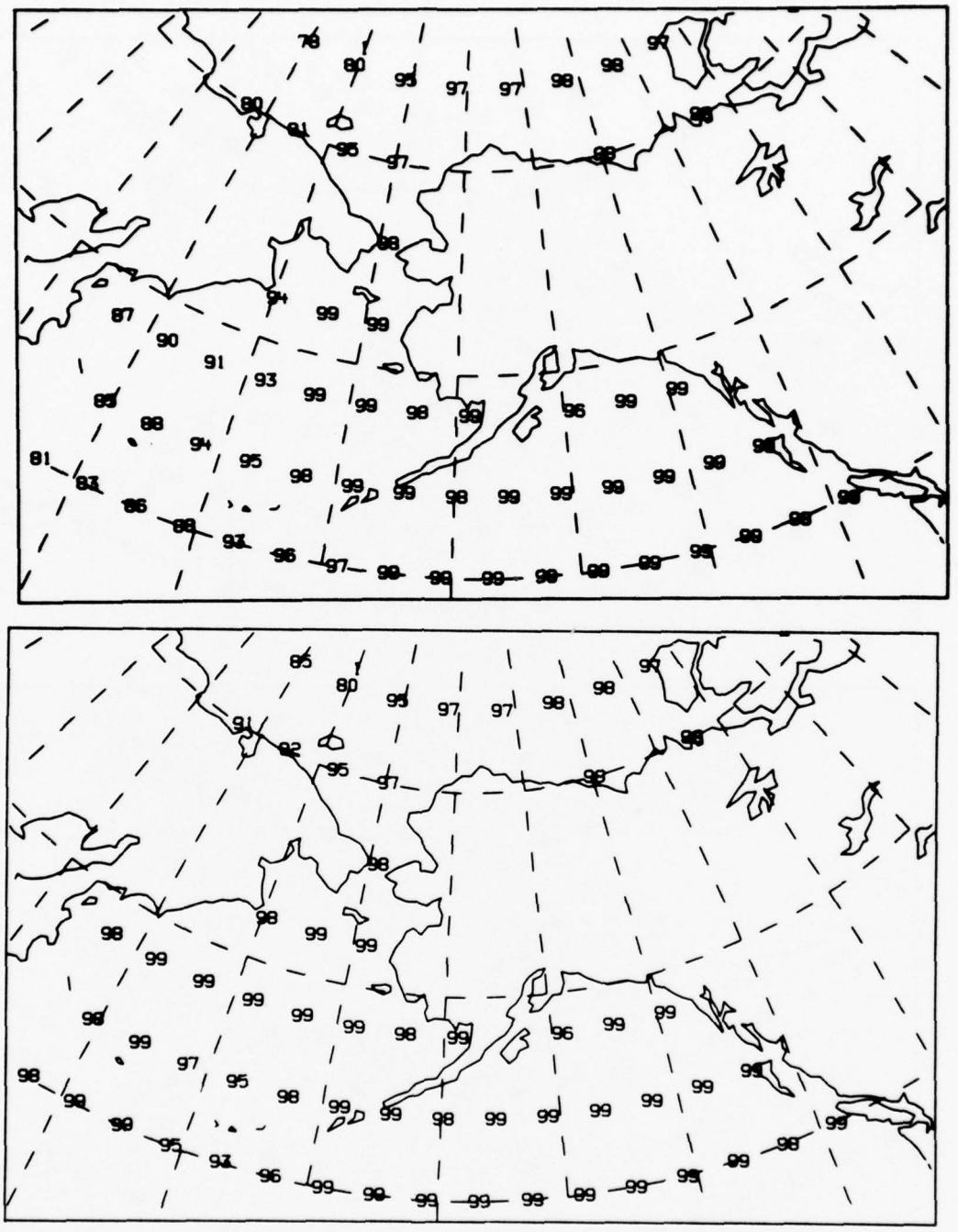

Figure 3. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak, 6 and 8 MHz, winter day and low solar activity.

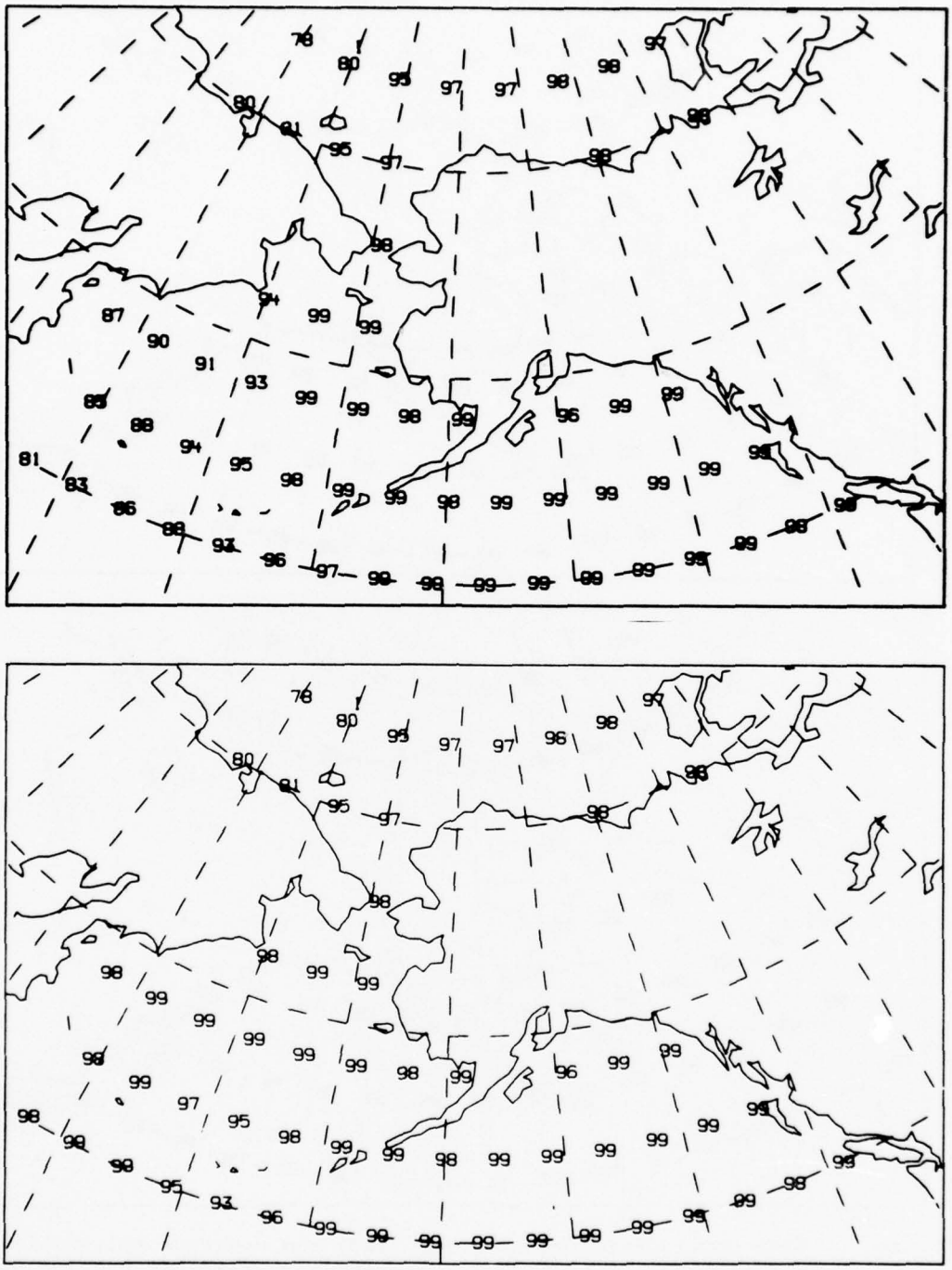

Figure 4. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak, 6 MHz, winter day and low solar activity.

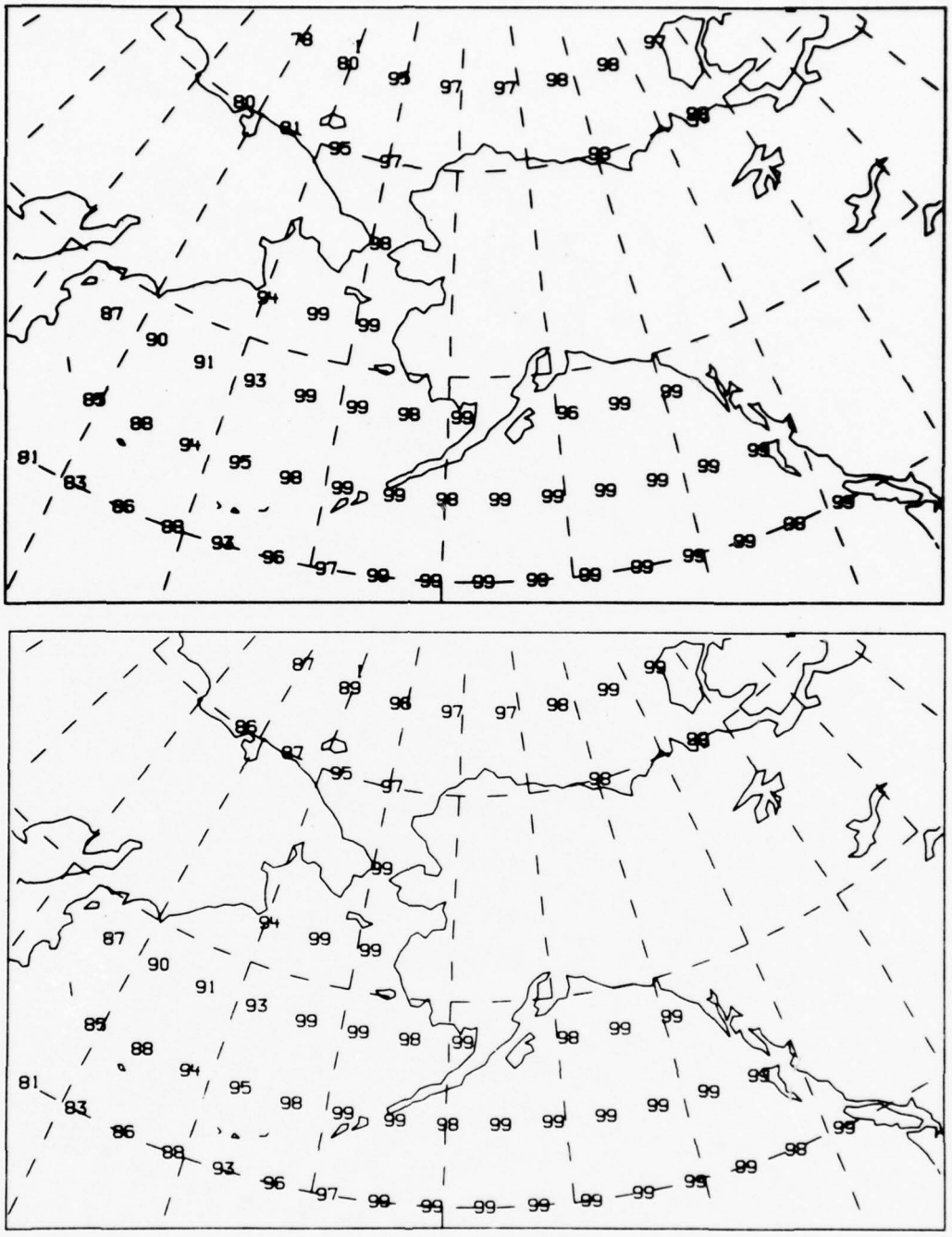

Figure 5. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 4, 6, and 8 MHz, winter day and low solar activity.

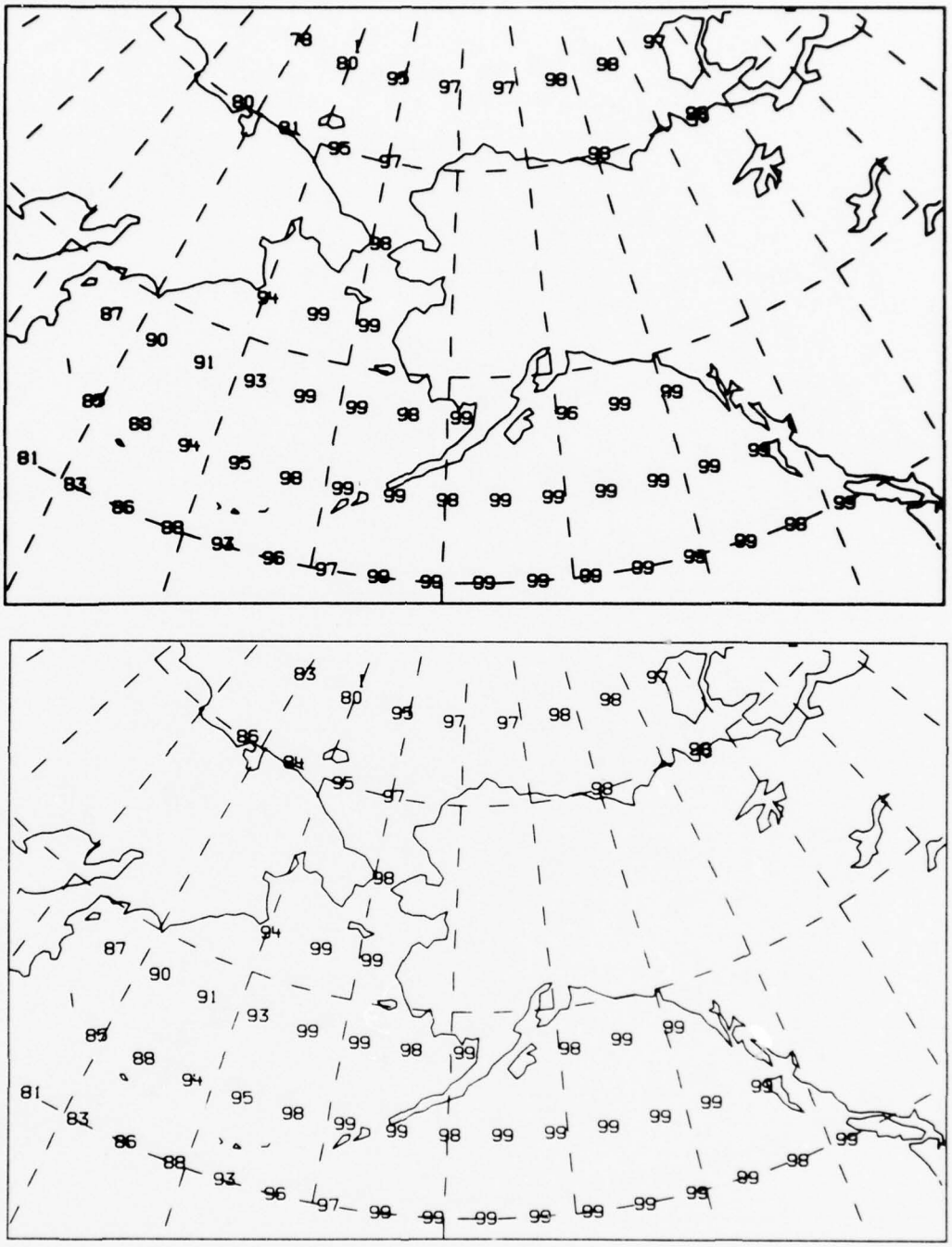

Figure 6. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 6 and 8 MHz, winter day and low solar activity.

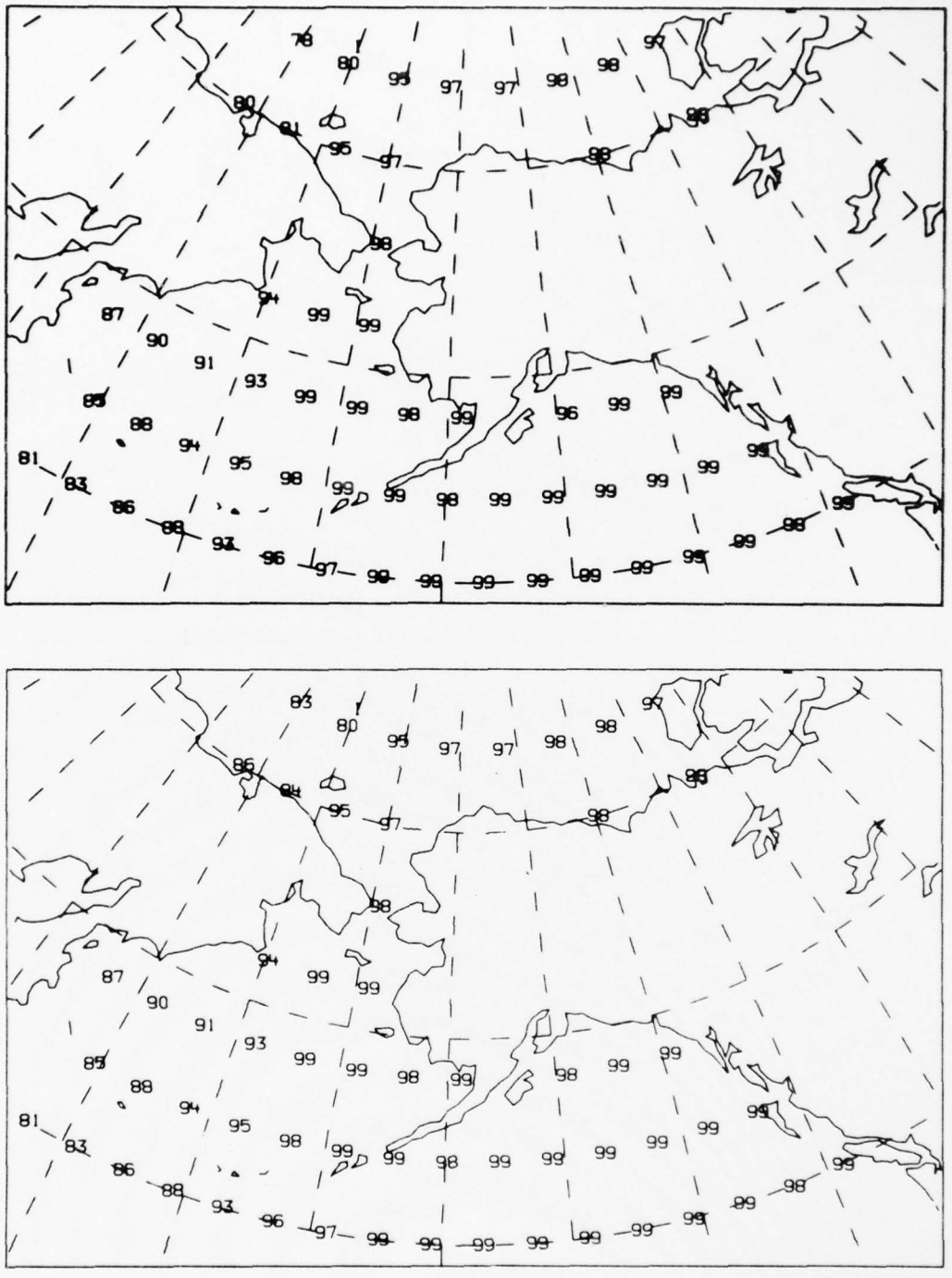

Figure 7. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 6 MHz, winter day and low solar activity.

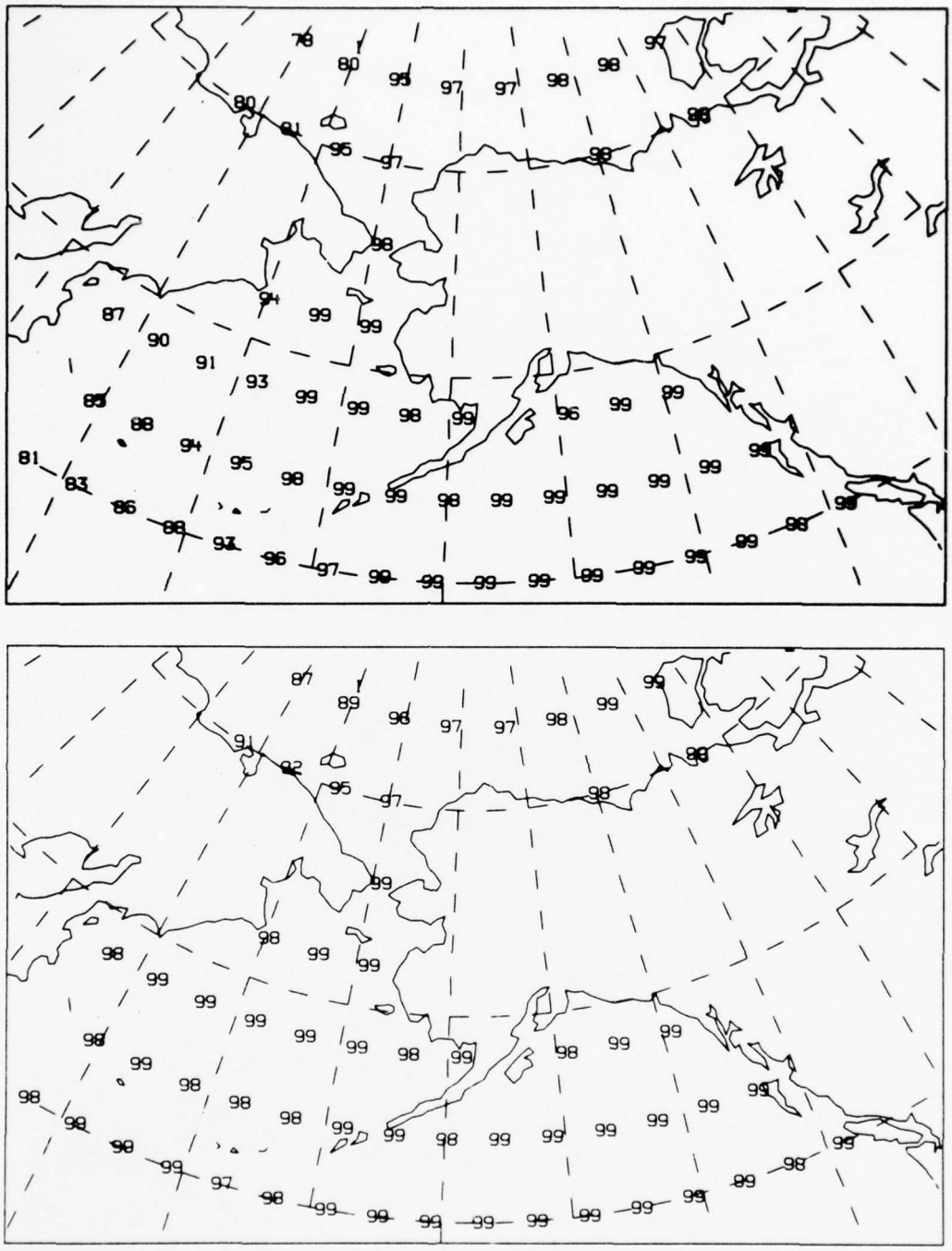

Figure 8. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 4, 6, and 8 MHz, winter day and low solar activity.

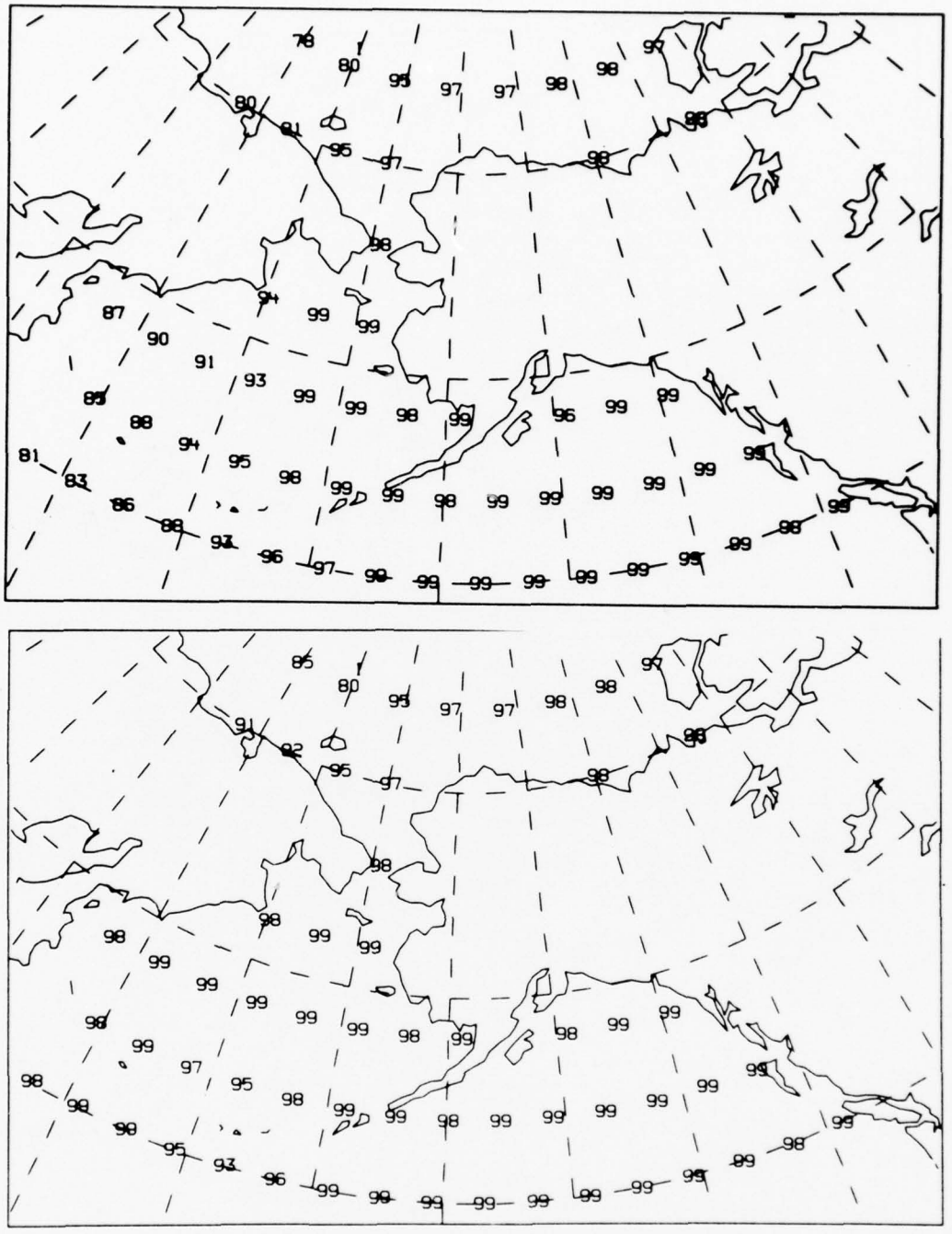

Figure 9. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 6 and 8 MHz, winter day and low solar activity.

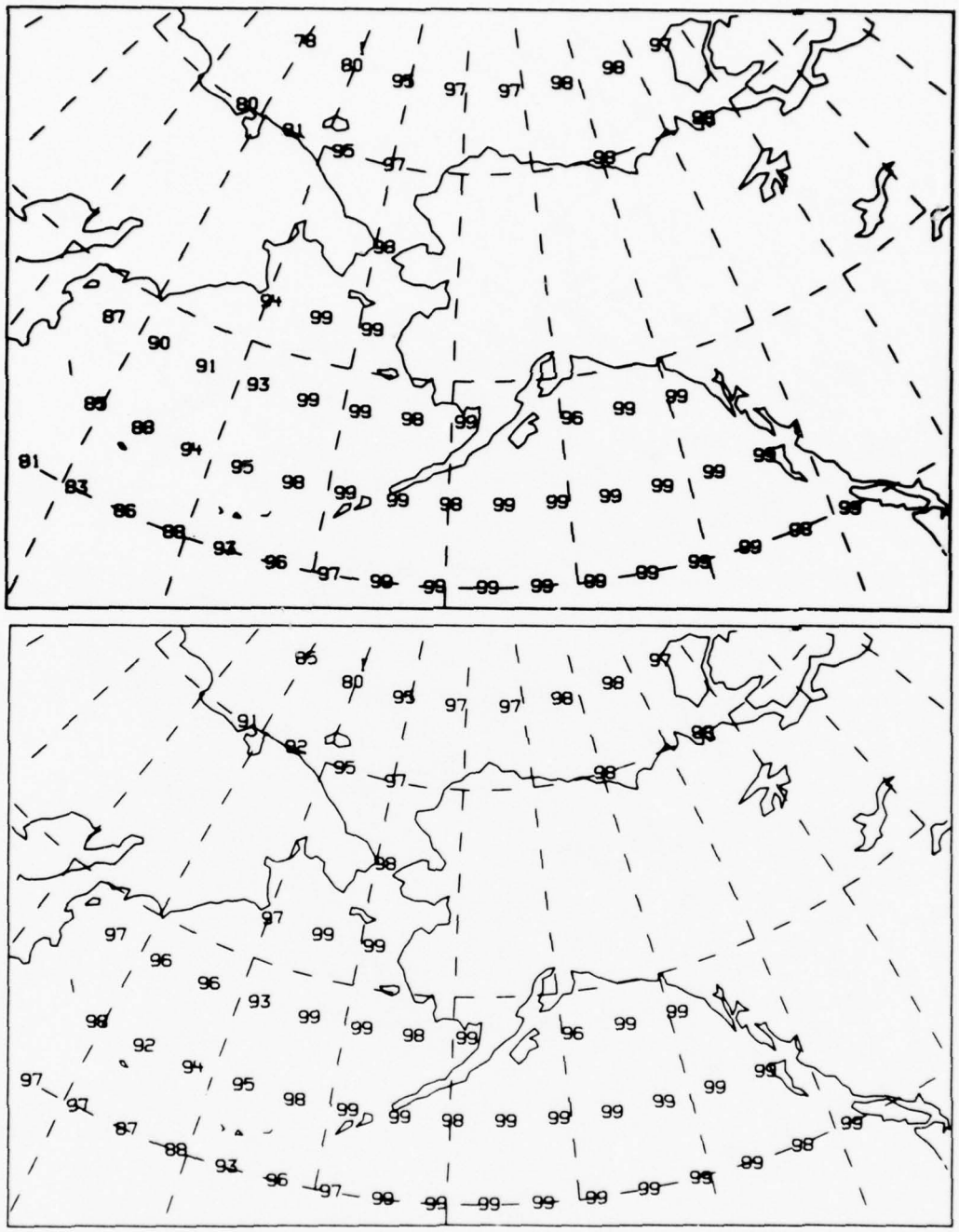

Figure 10. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 8 MHz, winter day and low solar activity.

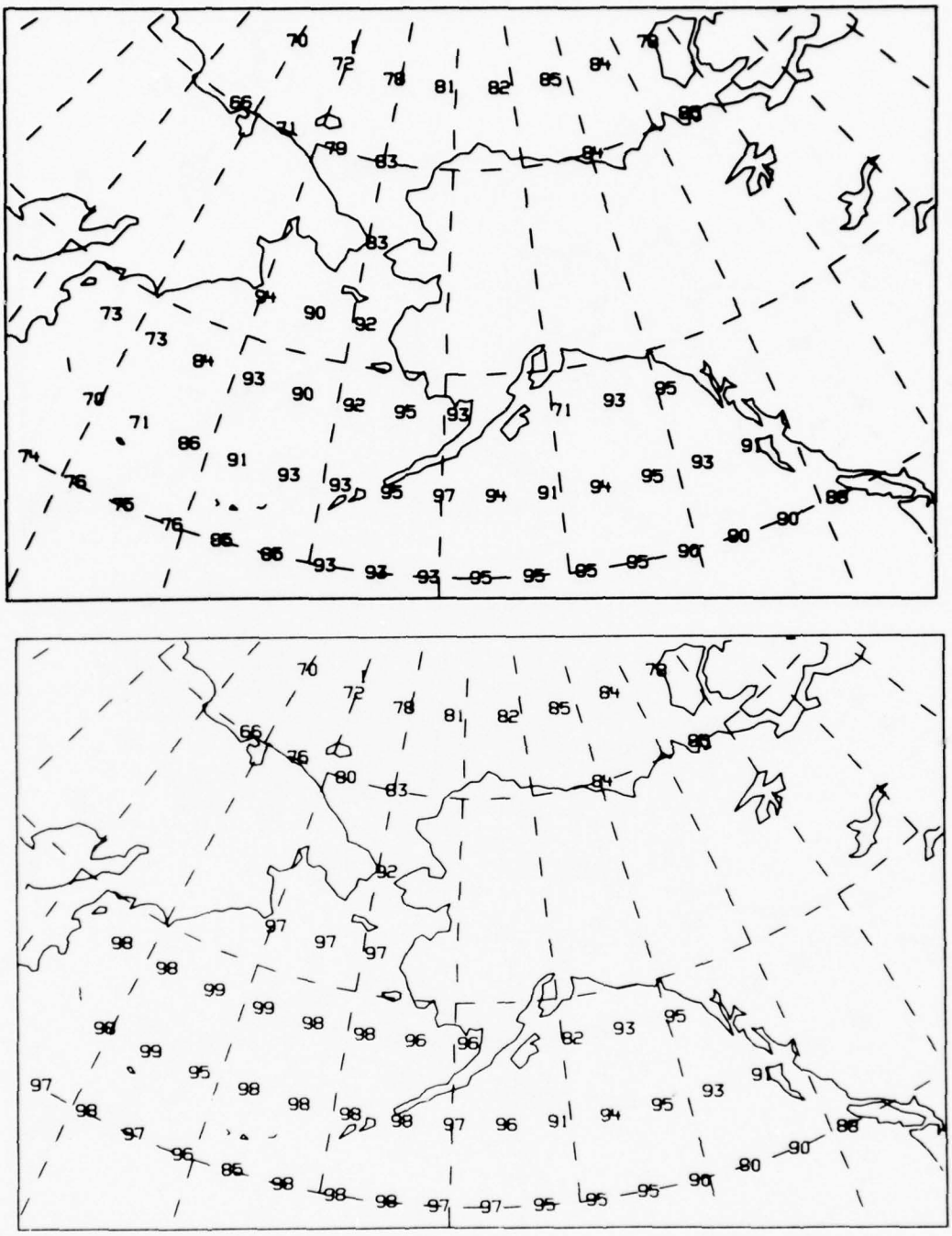

Figure 11. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak, 4, 6, and 8 MHz, winter day and high solar activity.

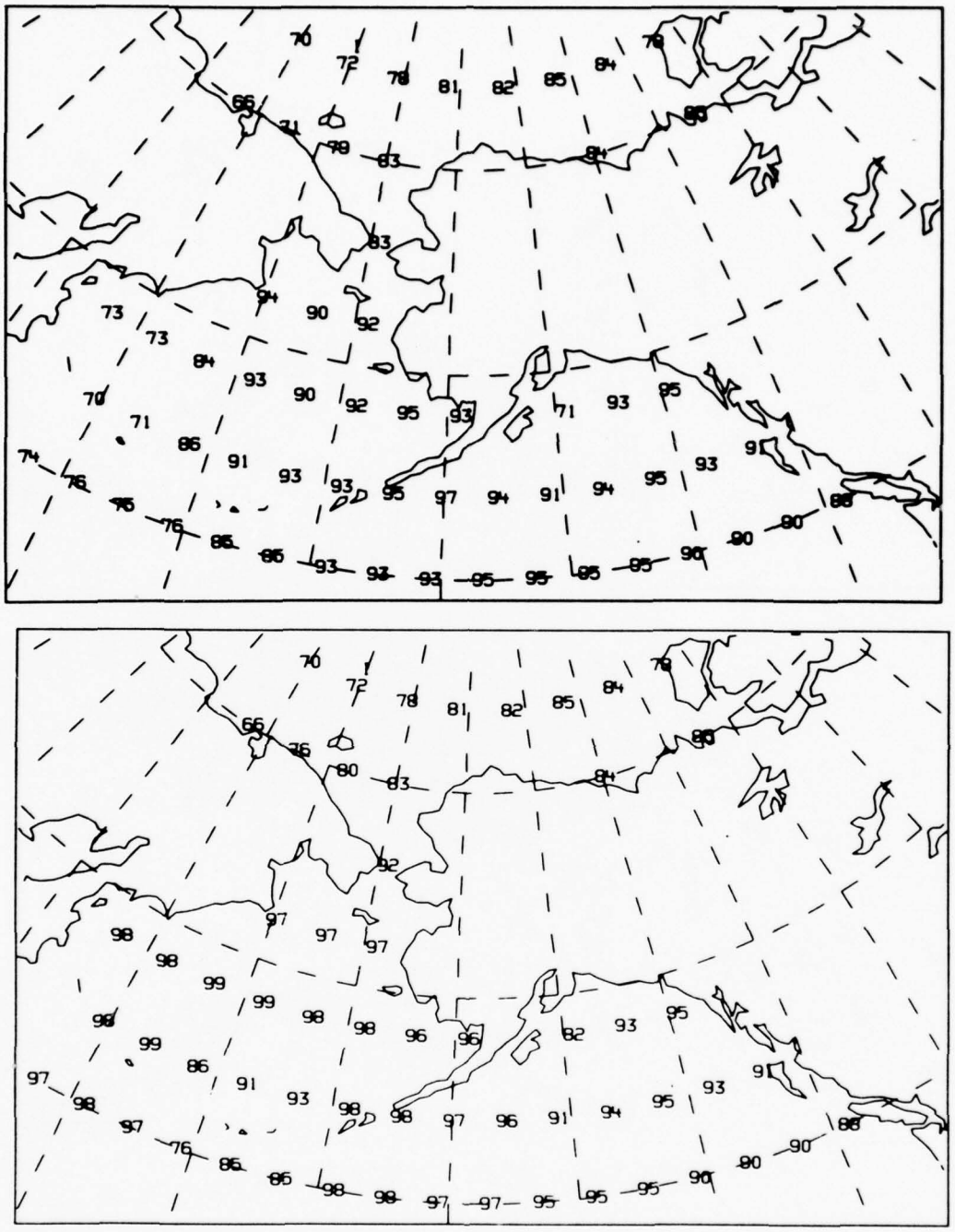

Figure 12. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak, 6 and 8 MHz, winter day and high solar activity.

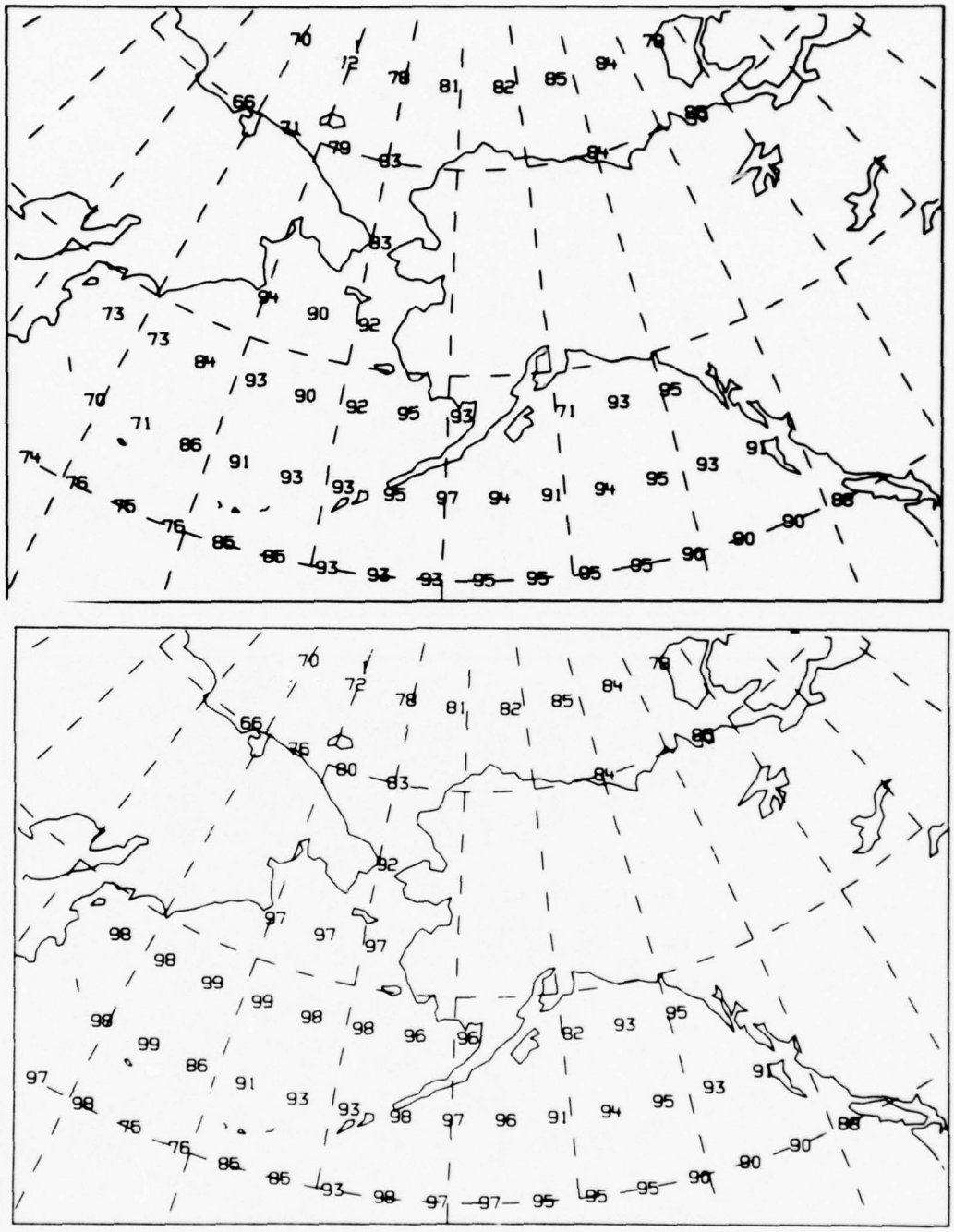

Figure 13. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak, 8 MHz, winter day and high solar activity.

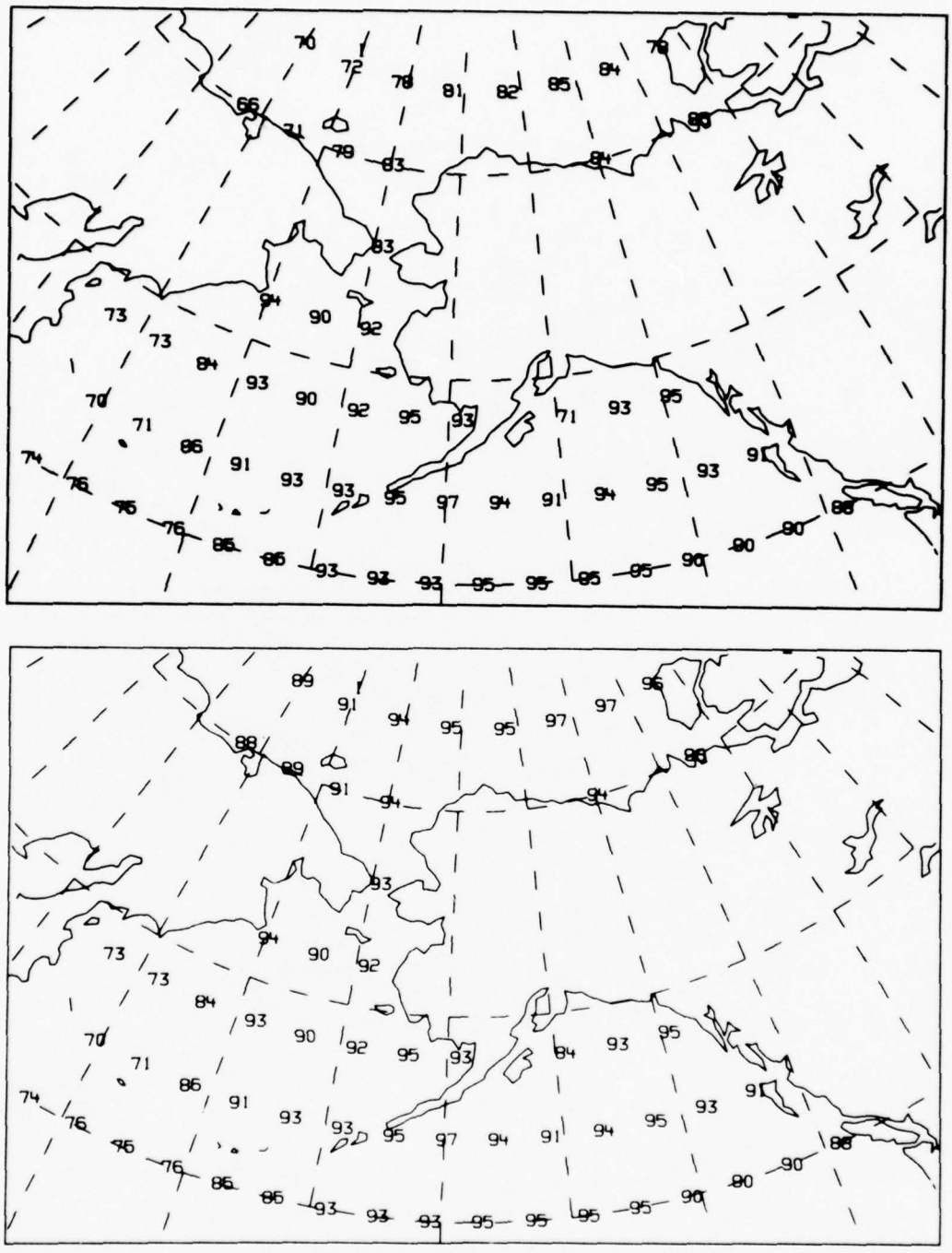

Figure 14. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 4, 6, and 8 MHz, winter day and high solar activity.

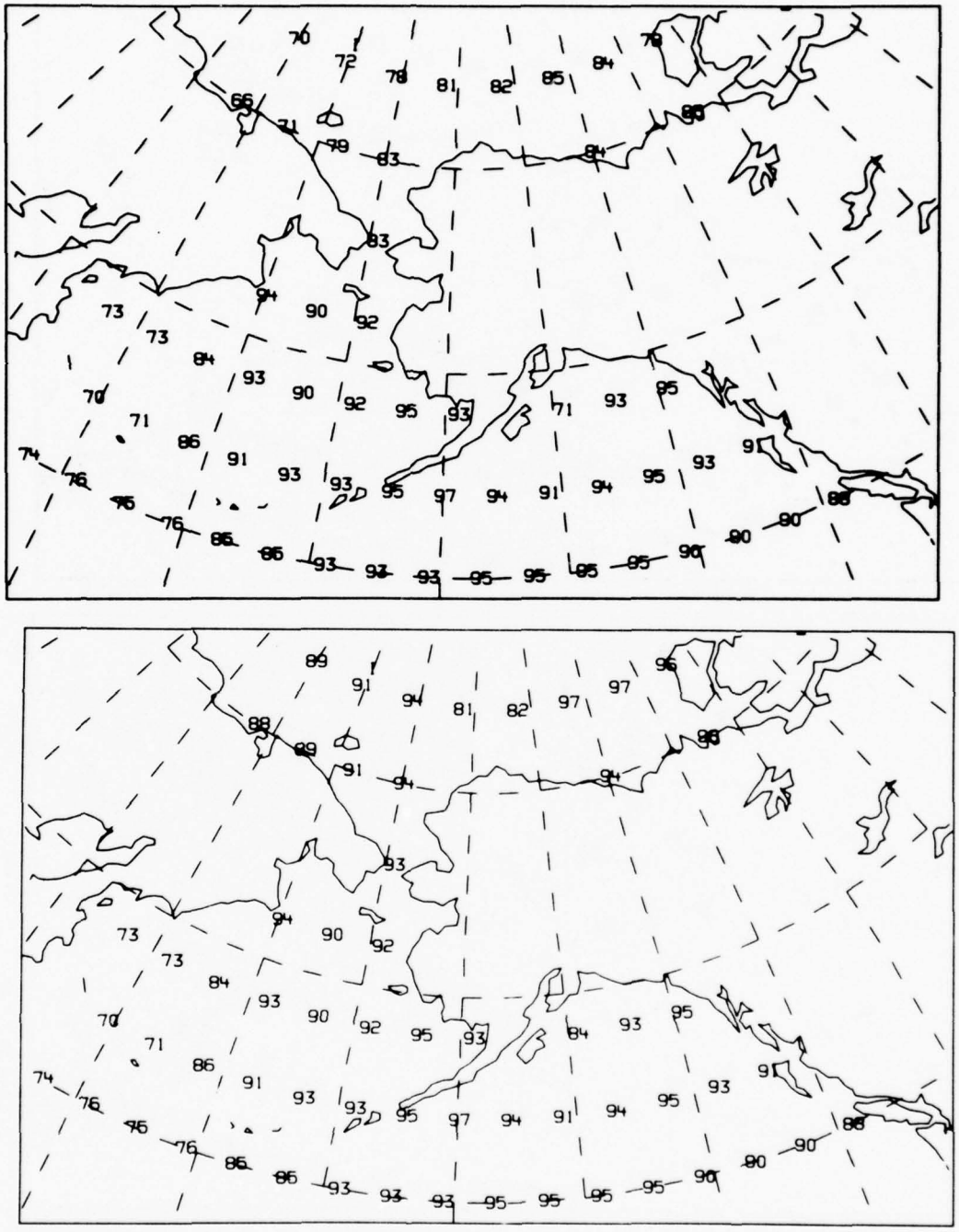

Figure 15. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 6 and 8 MHz, winter day and high solar activity.

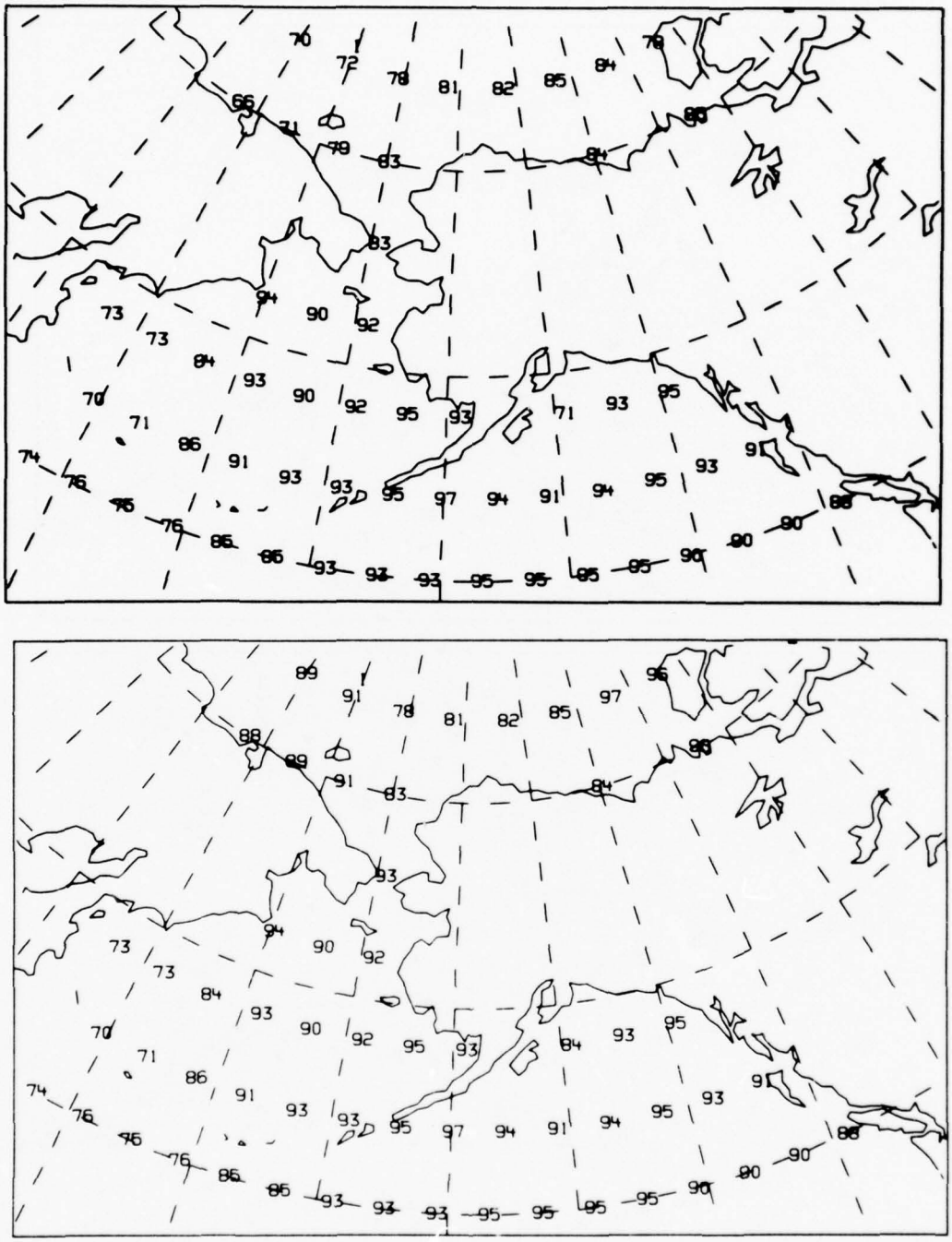

Figure 16. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 8 MHz, winter day and high solar activity.

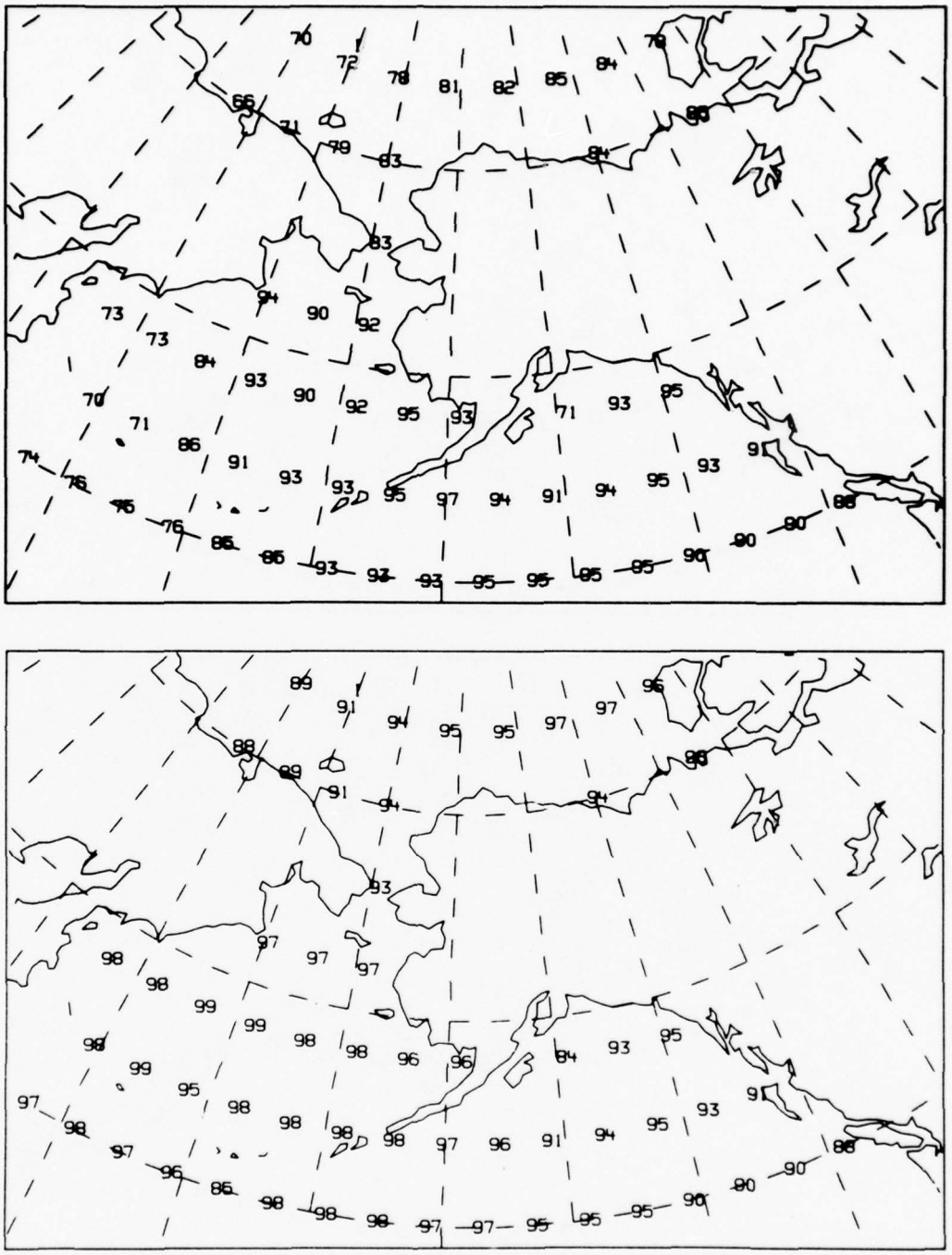

Figure 17. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 4, 6 and 8 MHz, winter day and high solar activity.

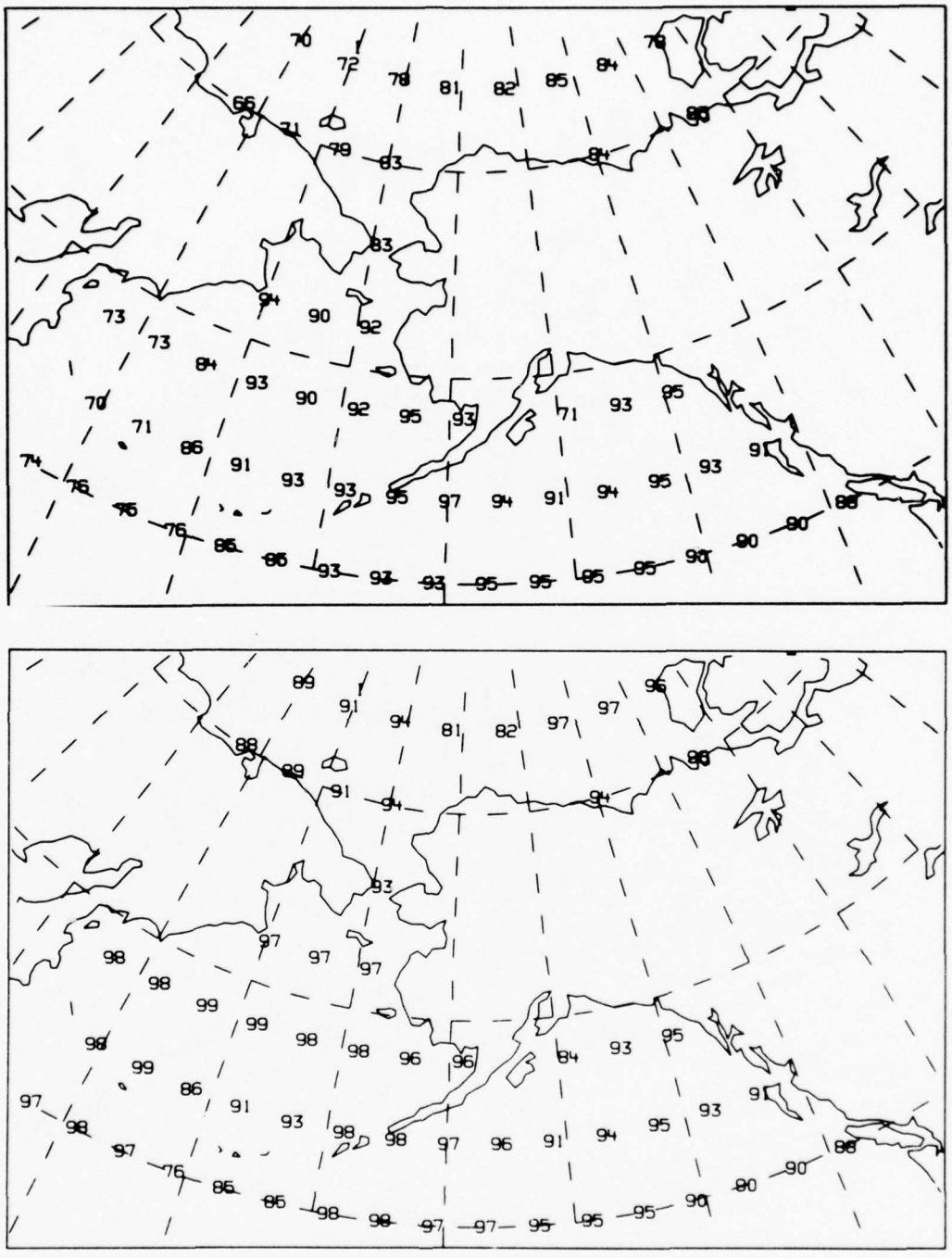

Figure 18. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 6 and 8 MHz, winter day and high solar activity.

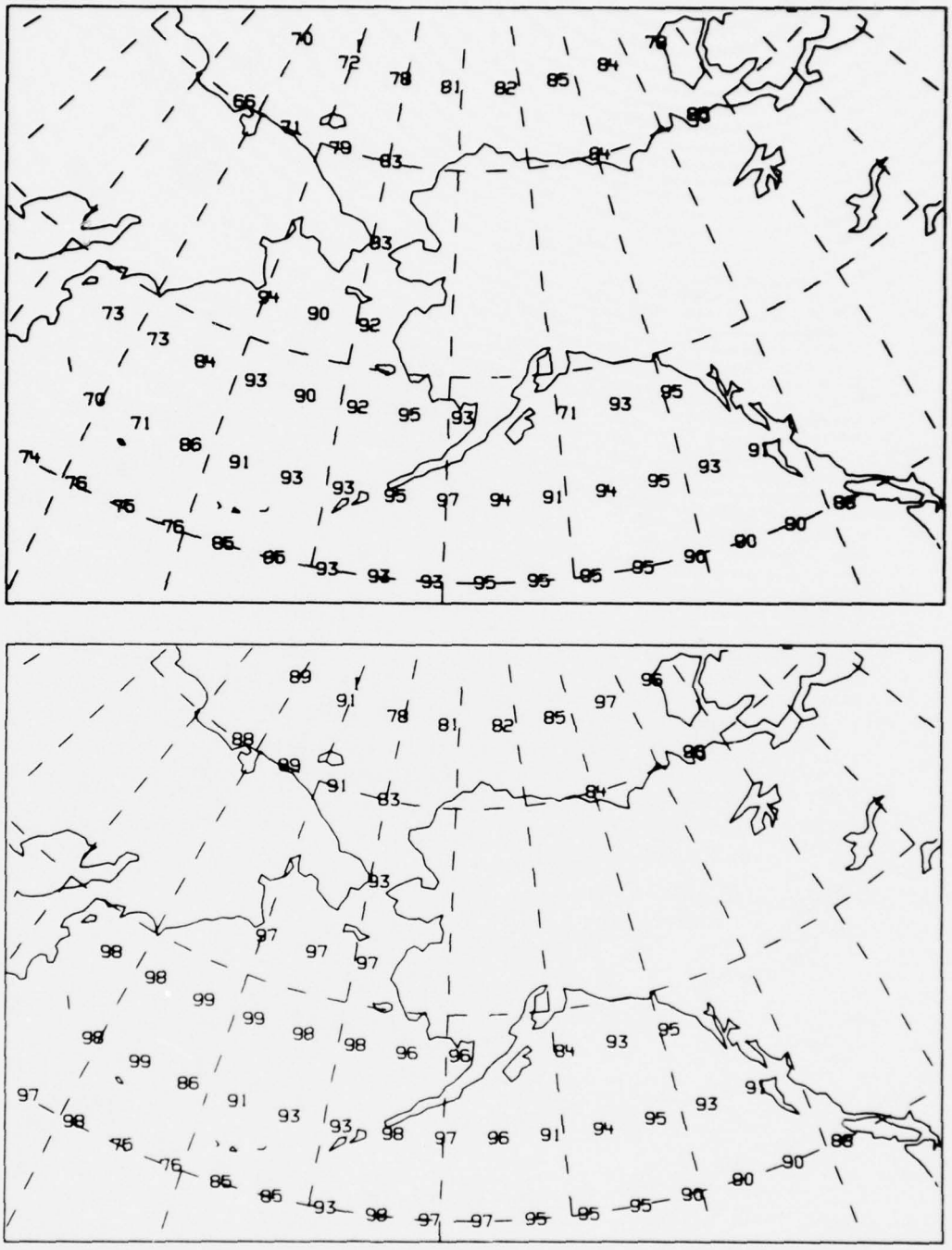

Figure 19. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 8 MHz, winter day and high solar activity.

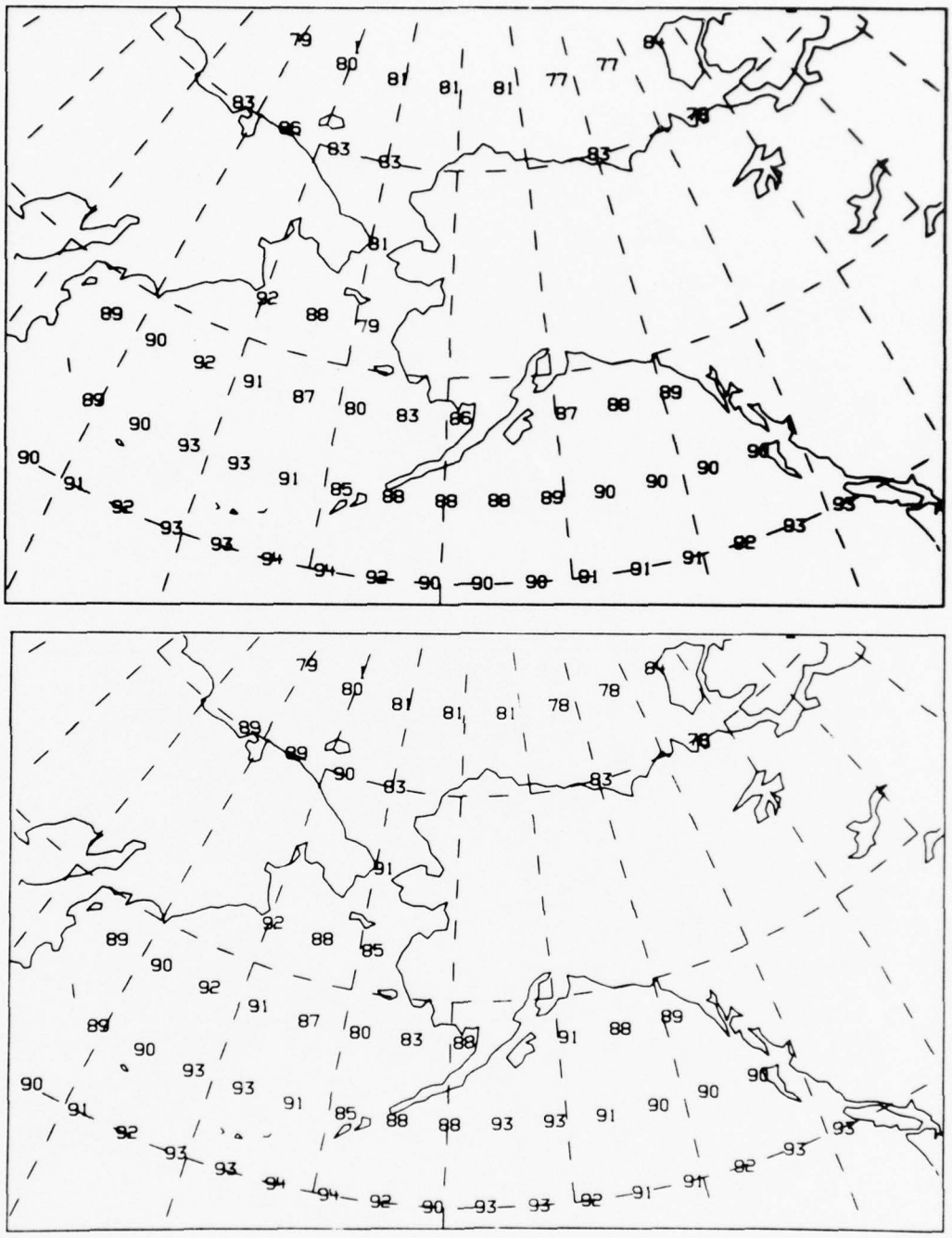

Figure 20. Base coverage reliability map (top) and coverage reliability (bottom) for the following: additional station - Adak, 4, 6 and 8 MHz, winter night and low solar activity.

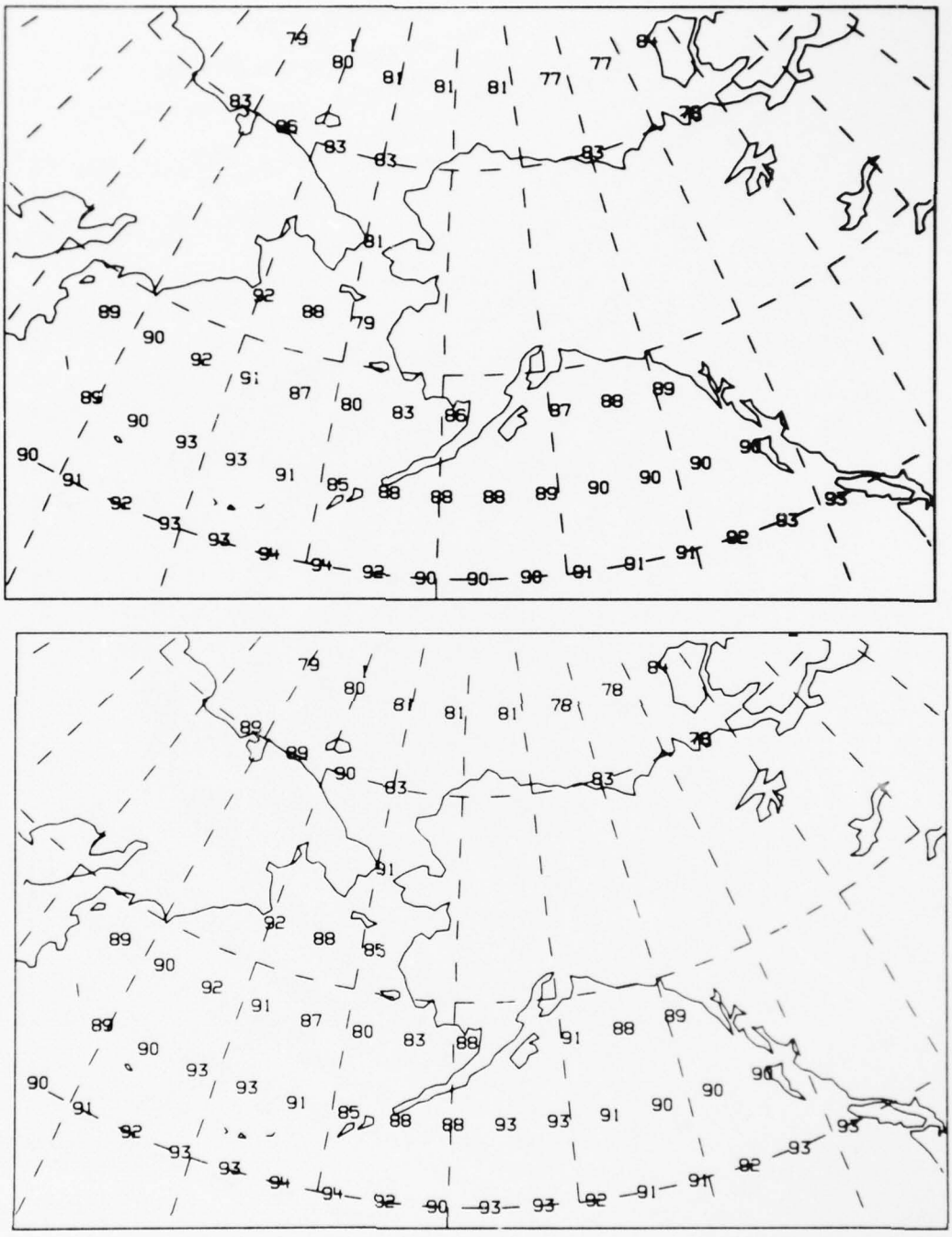

Figure 21. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak, 4 and 6 MHz, winter night and low solar activity.

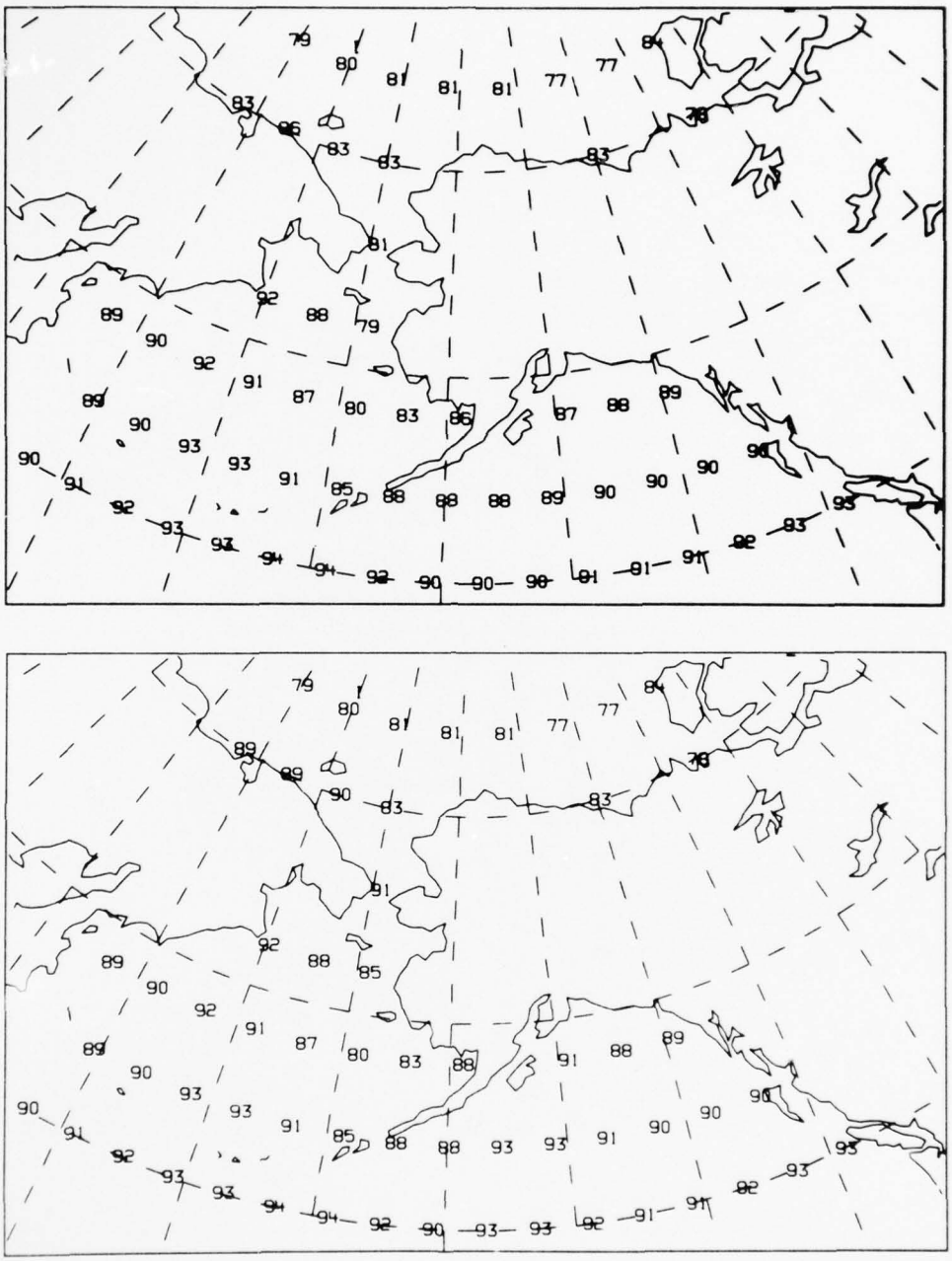

Figure 22. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak, 4 MHz, winter night and low solar activity.

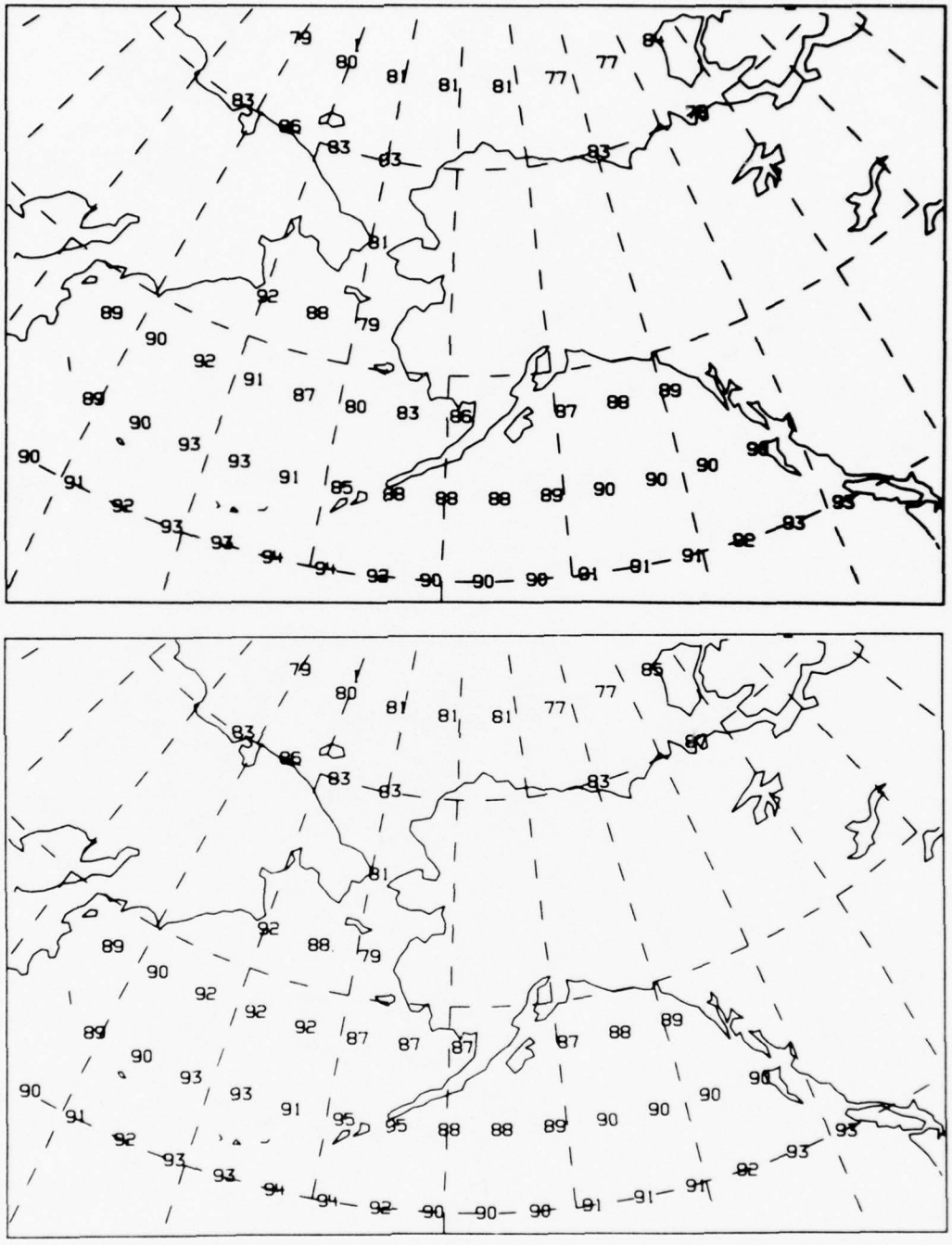

Figure 23. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 4, 6 and 8 MHz, winter night and low solar activity.

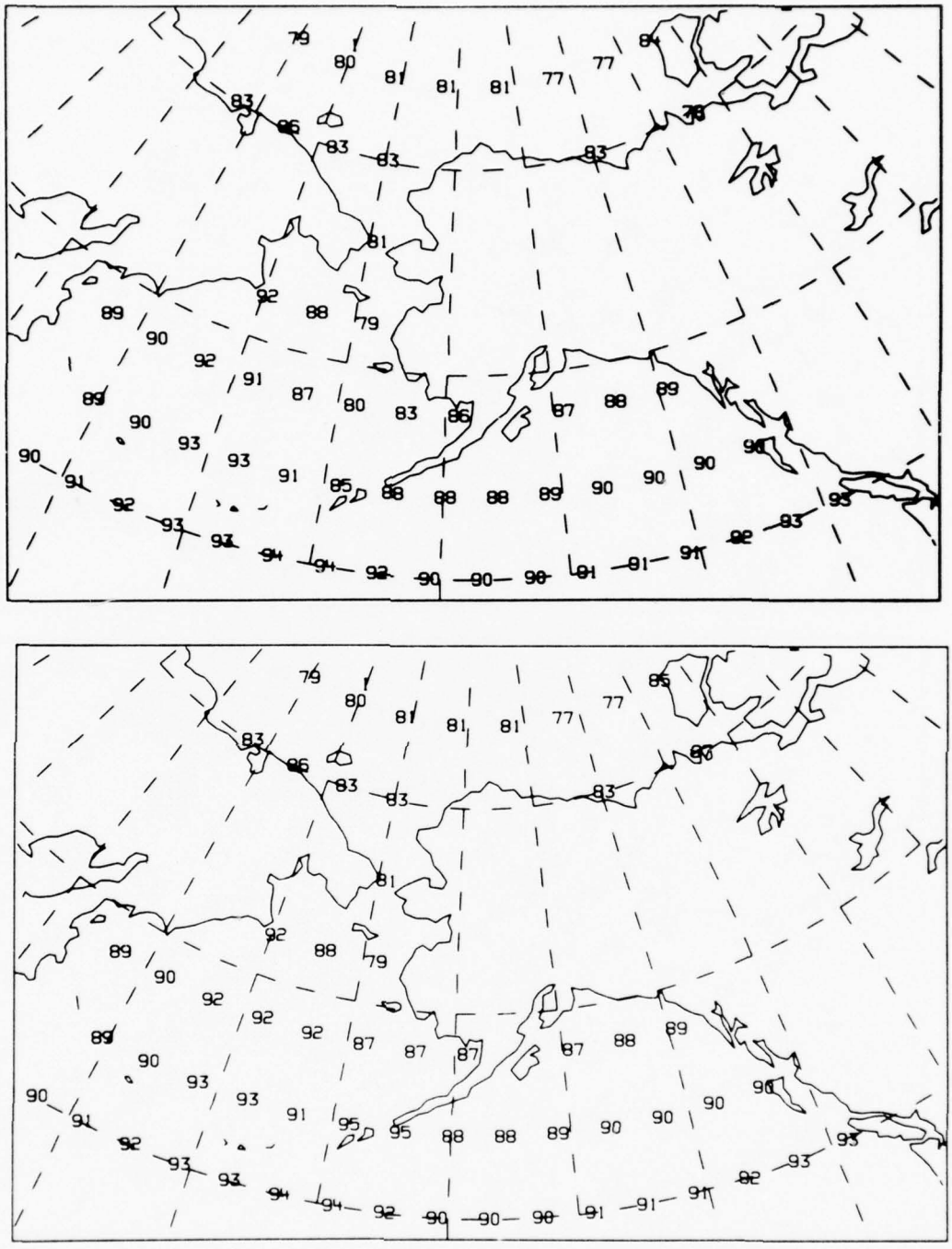

Figure 24. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 4 and 6 MHz, winter night and low solar activity.

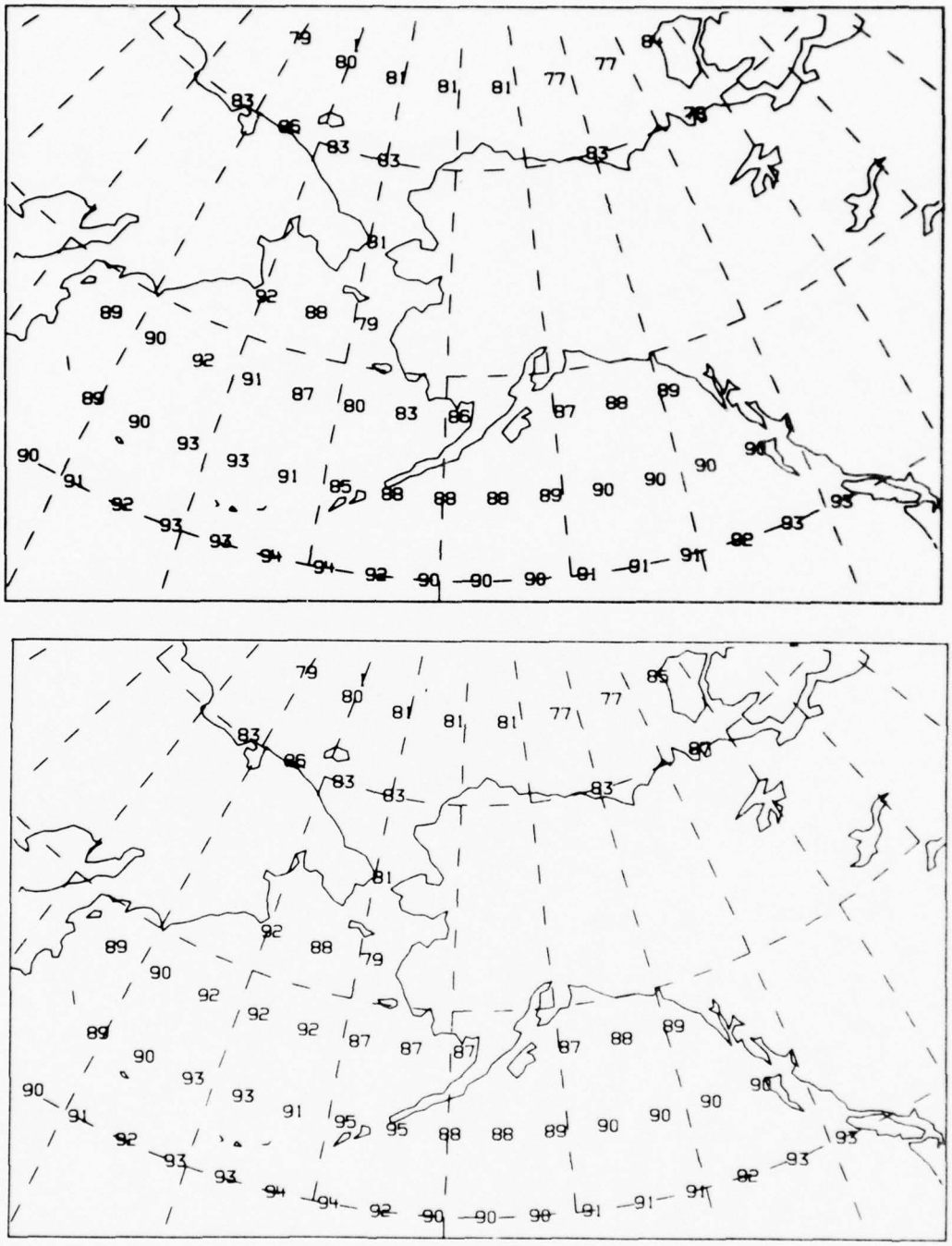

Figure 25. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 4 MHz, winter night and low solar activity.

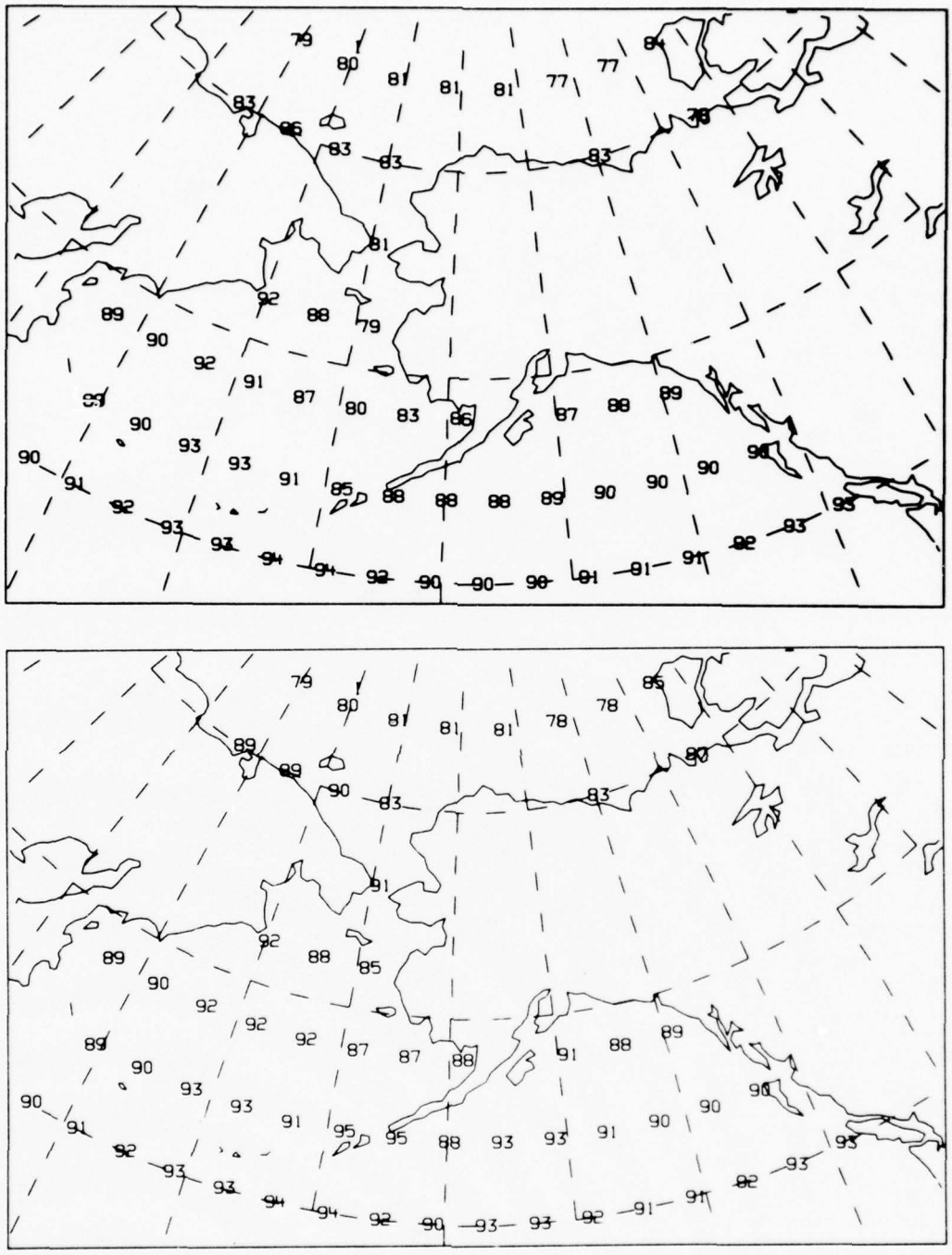

Figure 26. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak and Barrow, 4, 6, and 8 MHz, winter night and low solar activity.

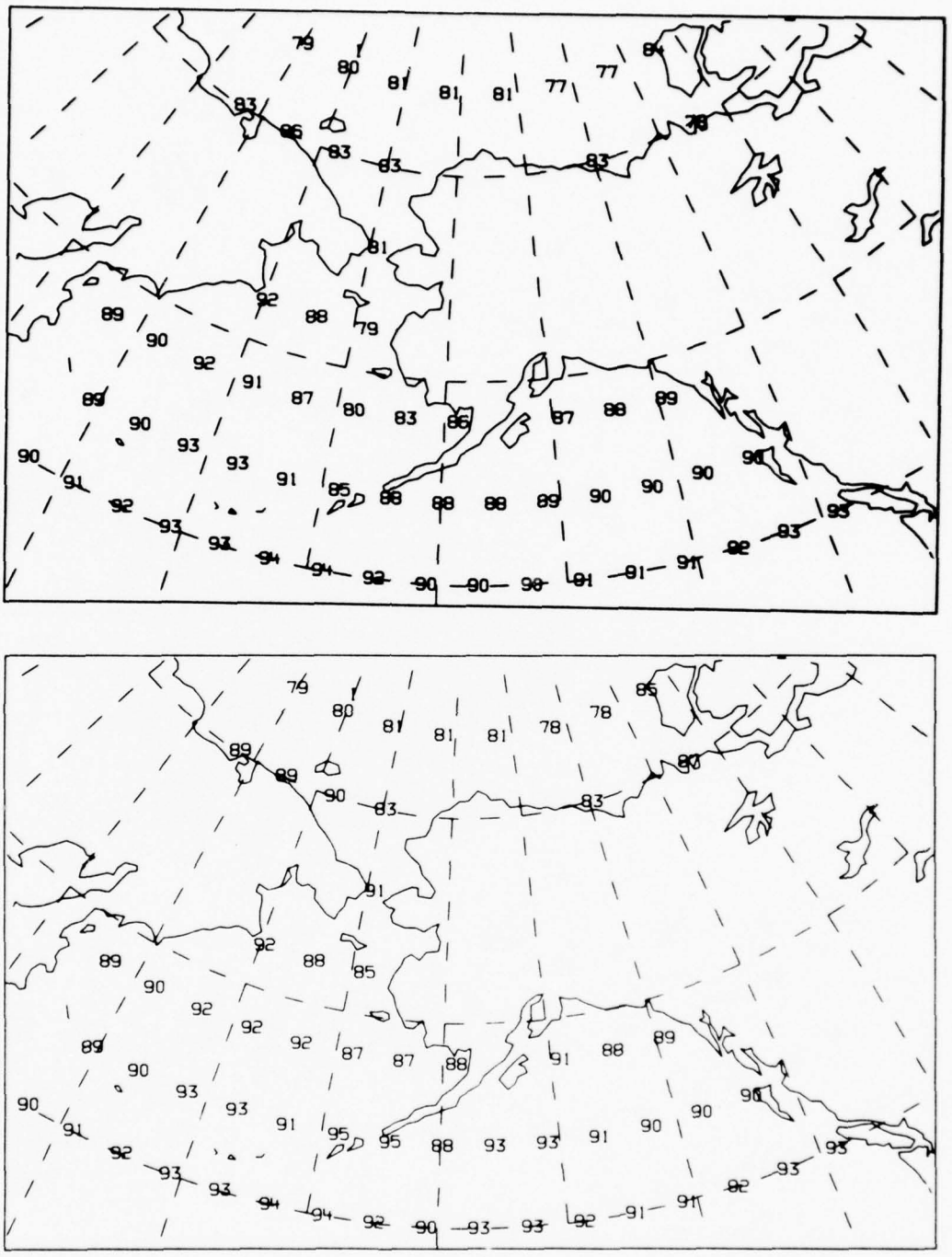

Figure 27. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 4 and 6 MHz, winter night and low solar activity.

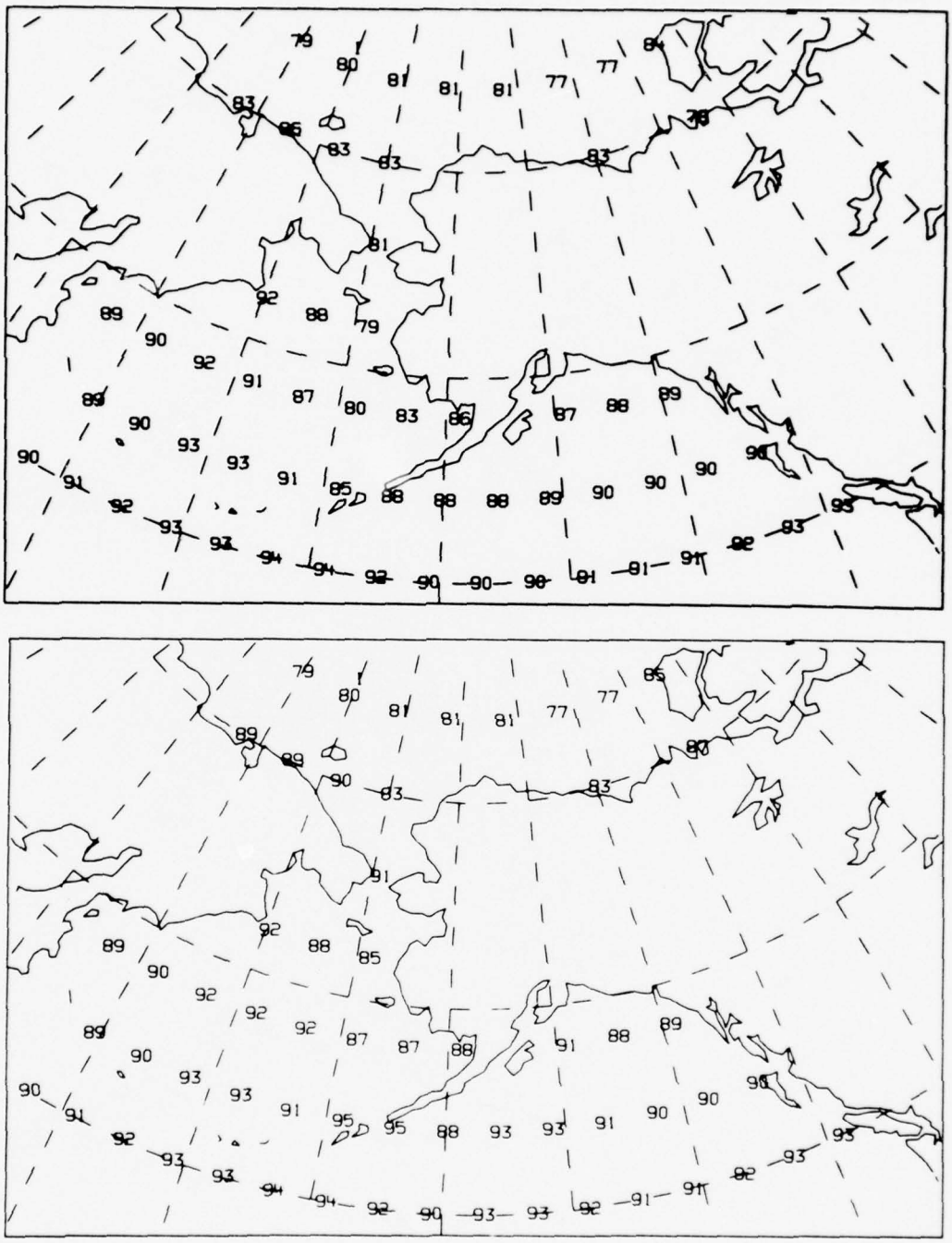

Figure 28. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 4 MHz, winter night and low solar activity.

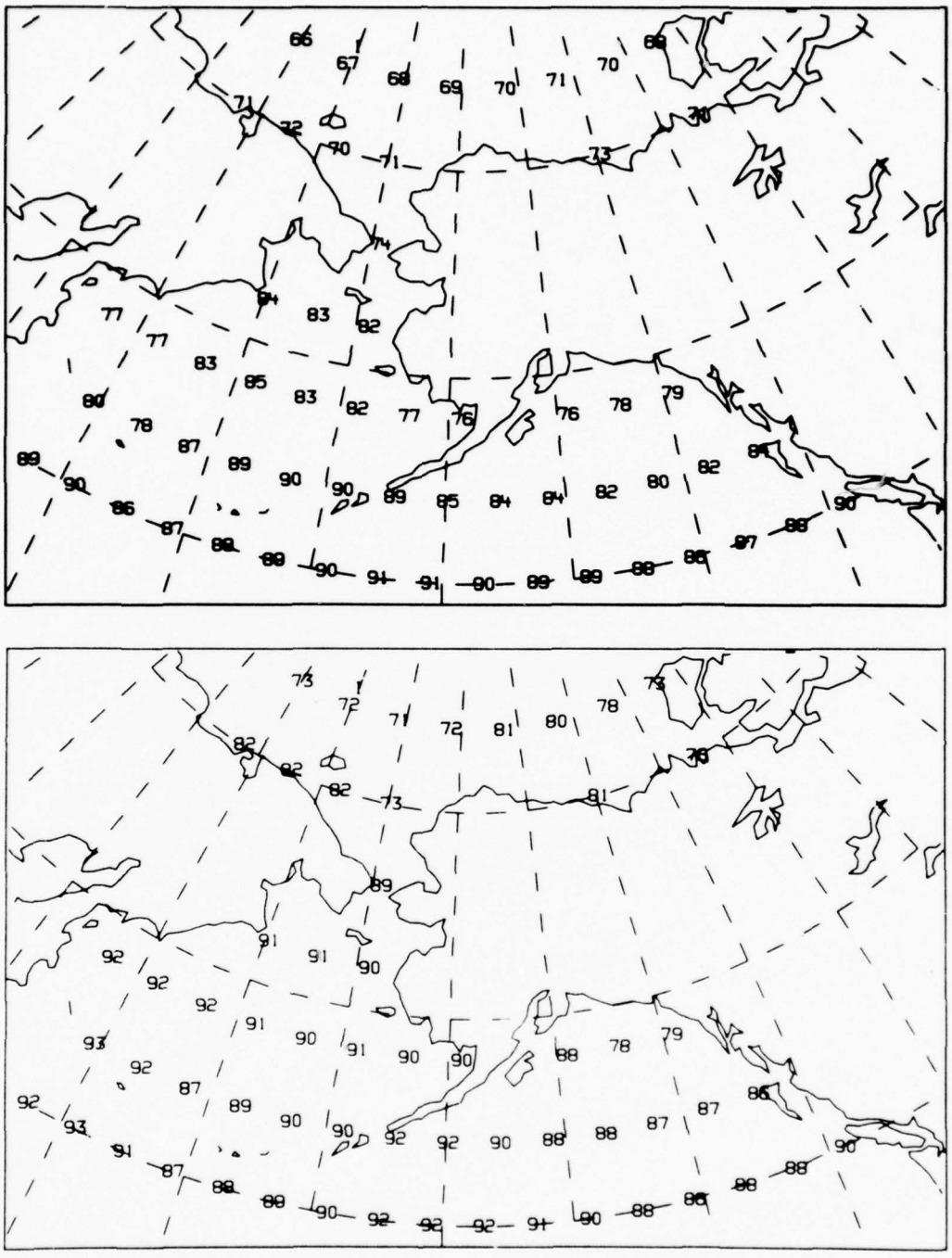

Figure 29. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak, 4, 6 and 8 MHz, winter night and high solar activity.

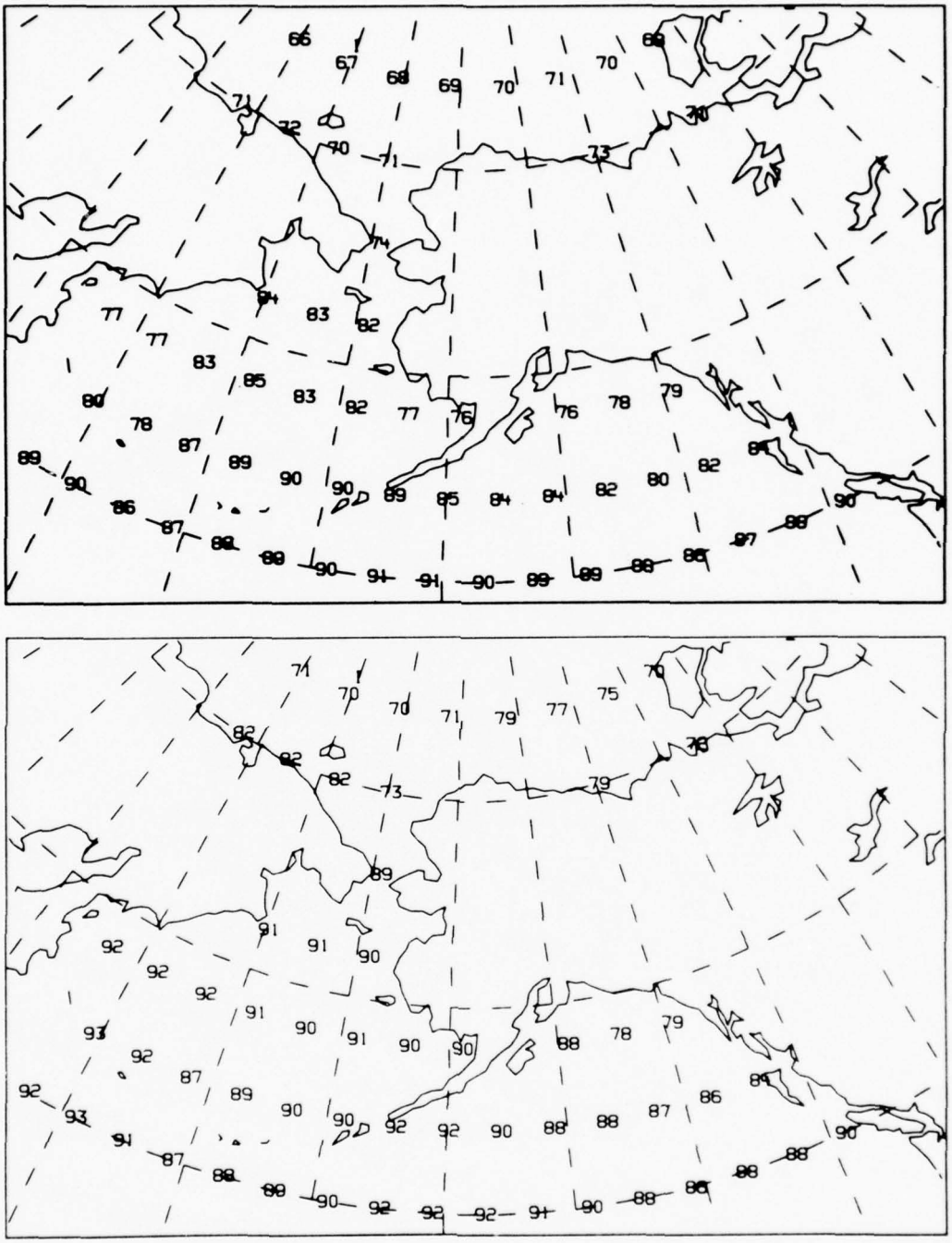

Figure 30. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak, 4 and 6 MHz, winter night and high solar activity.

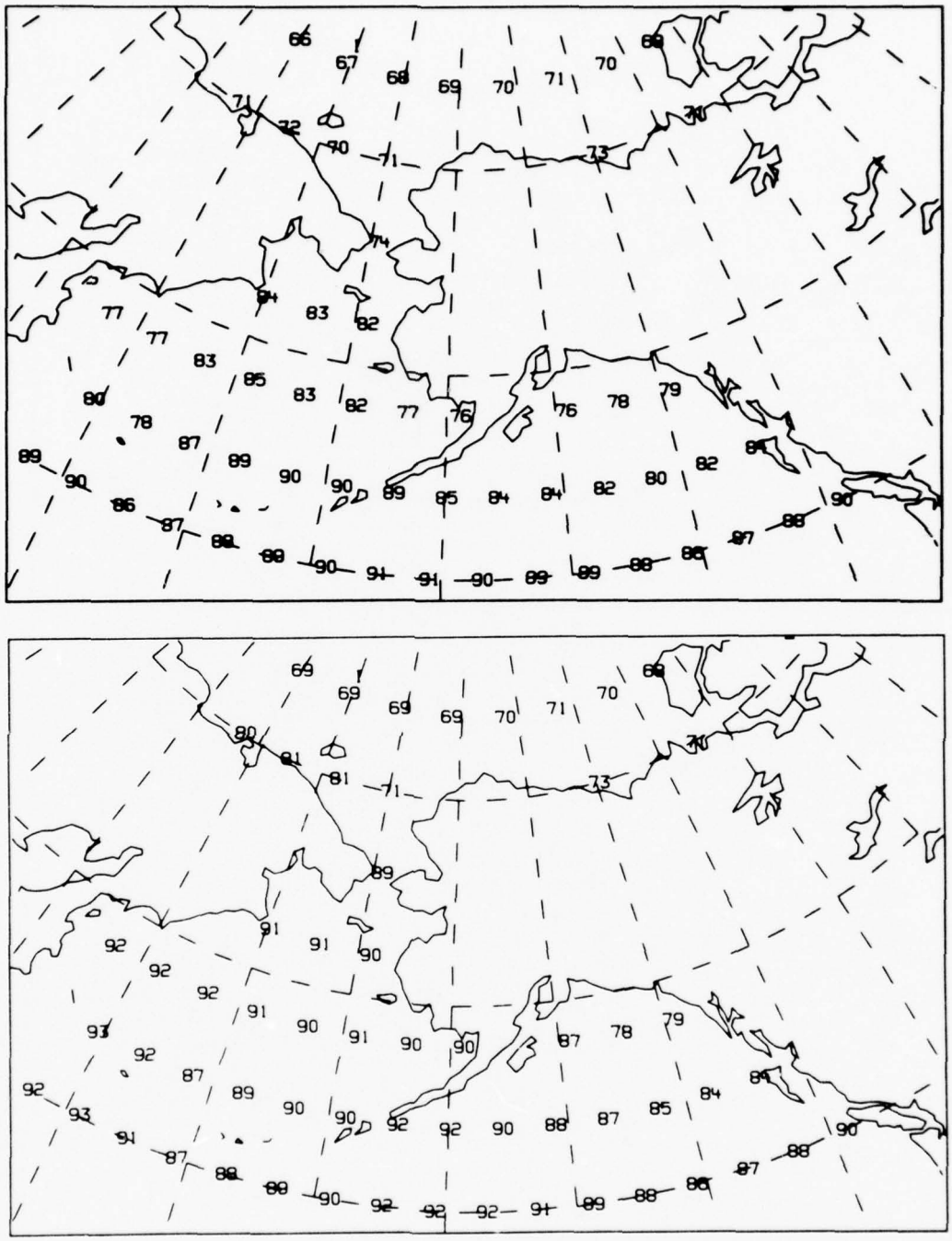

Figure 31. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak, 4 MHz, winter night and high solar activity.

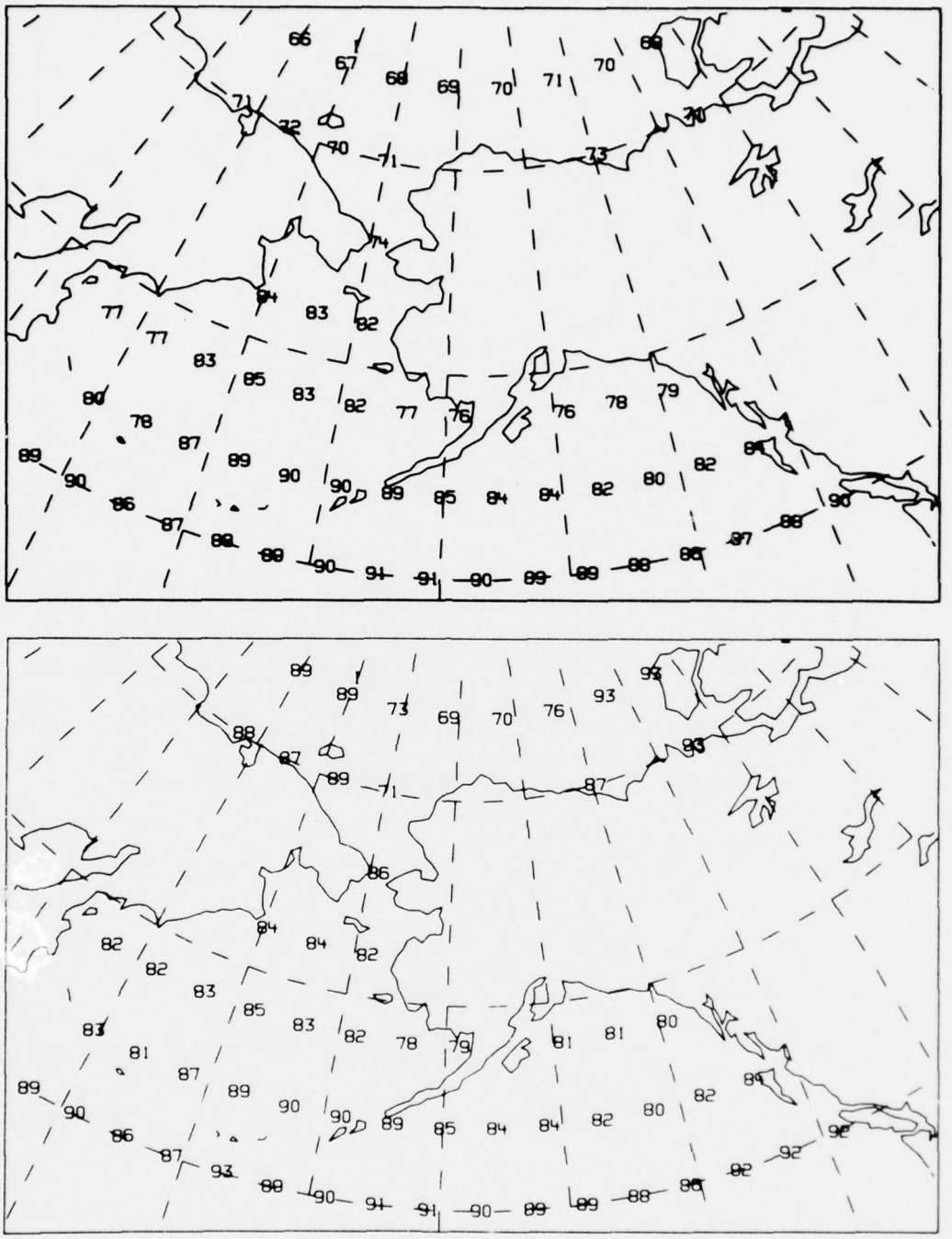

Figure 32. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 4, 6 and 8 MHz, winter night and high solar activity.

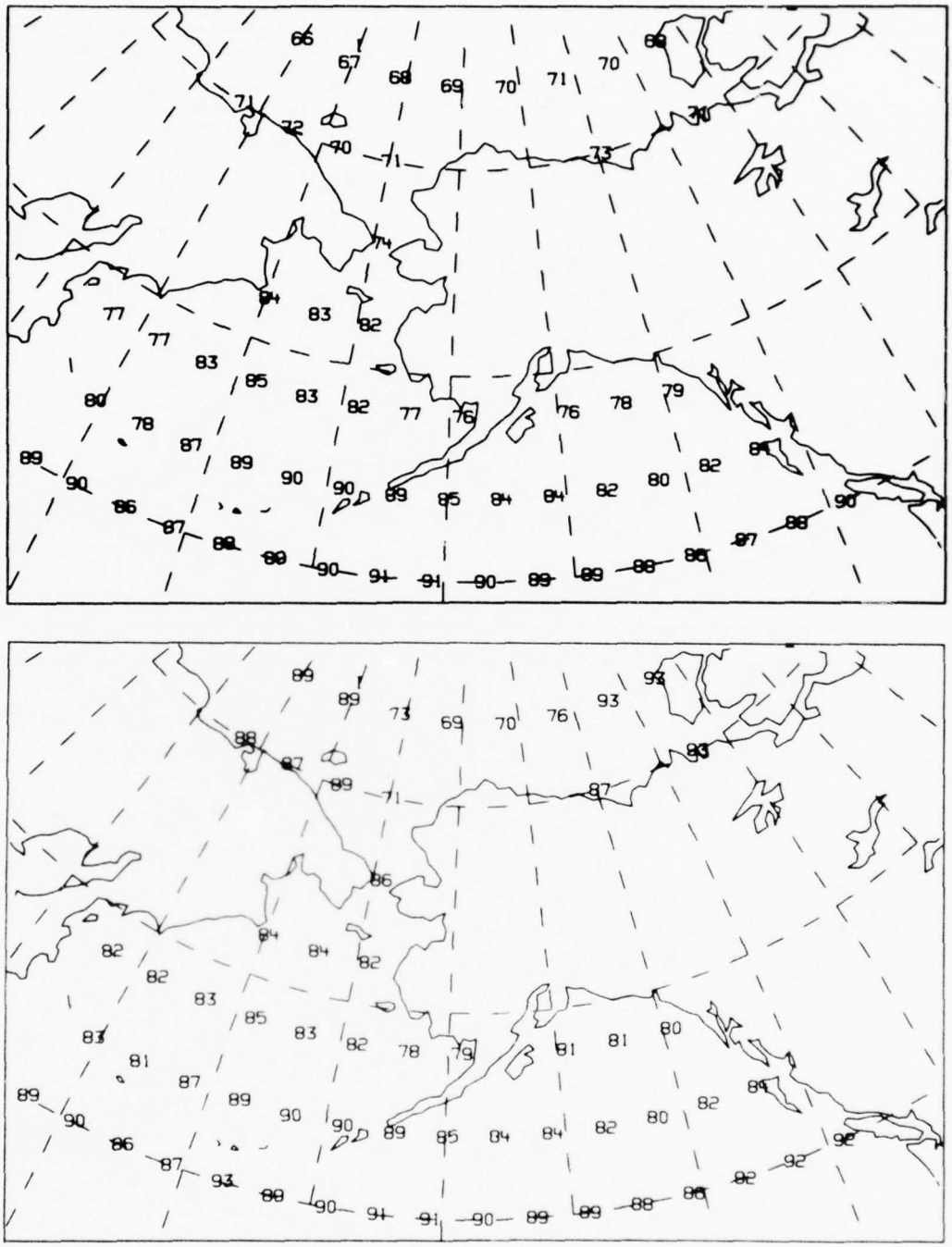

Figure 33. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 4 and 6 MHz, winter night and high solar activity.

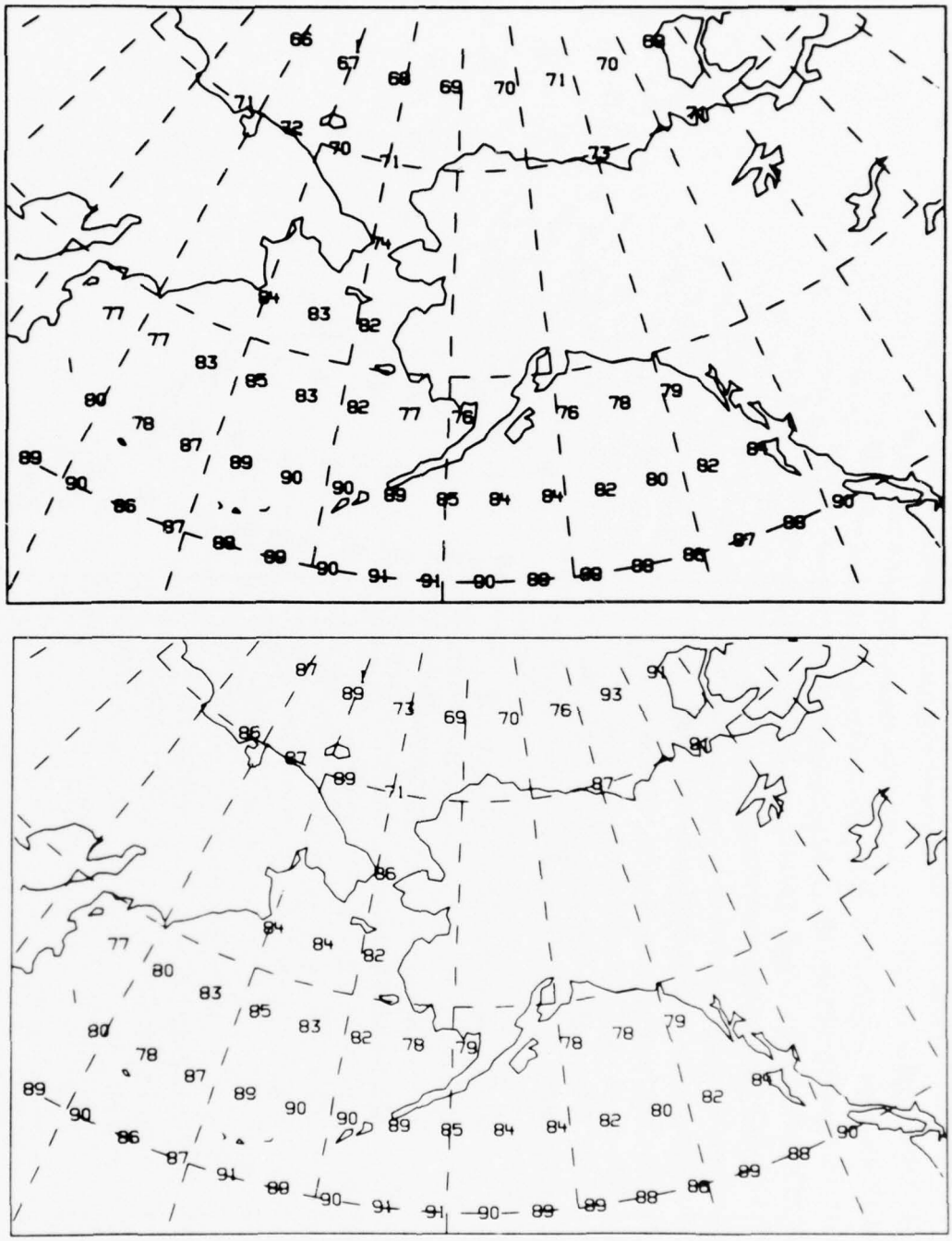

Figure 34. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 4 MHz, winter night and high solar activity.

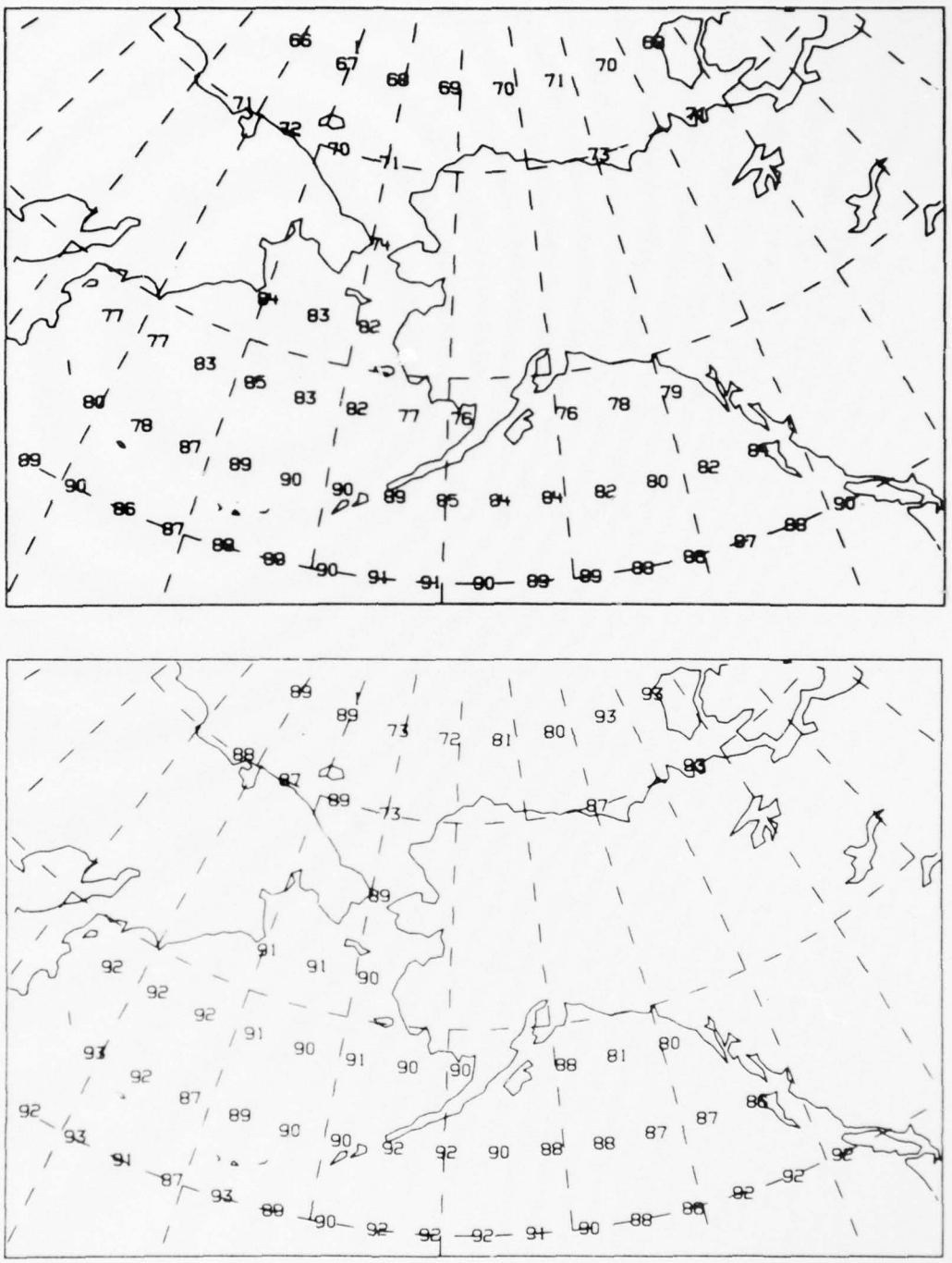

Figure 35. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 4, 6 and 8 MHz, winter night and high solar activity.

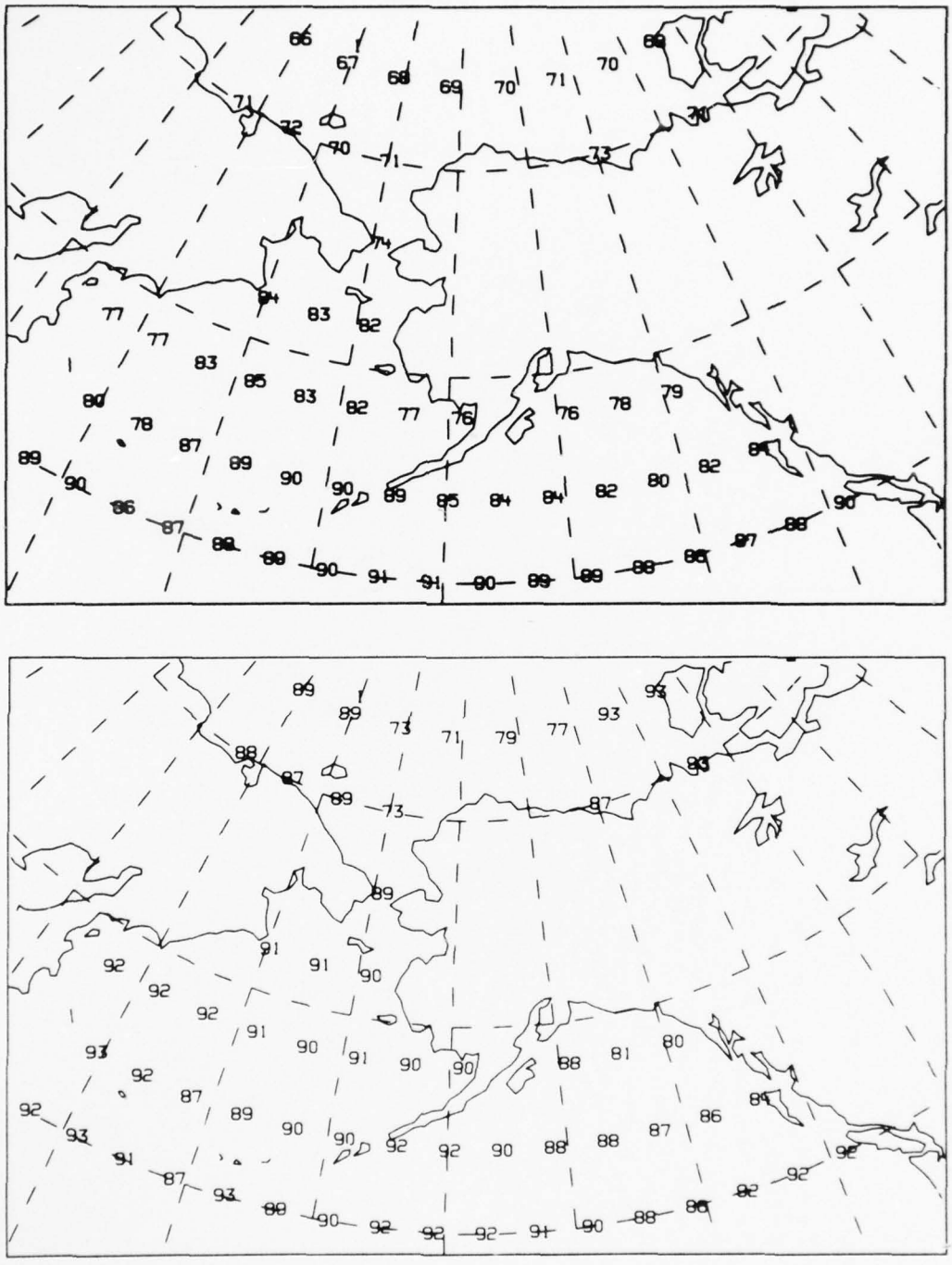

Figure 36. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 4 and 6 MHz, winter night and high solar activity.

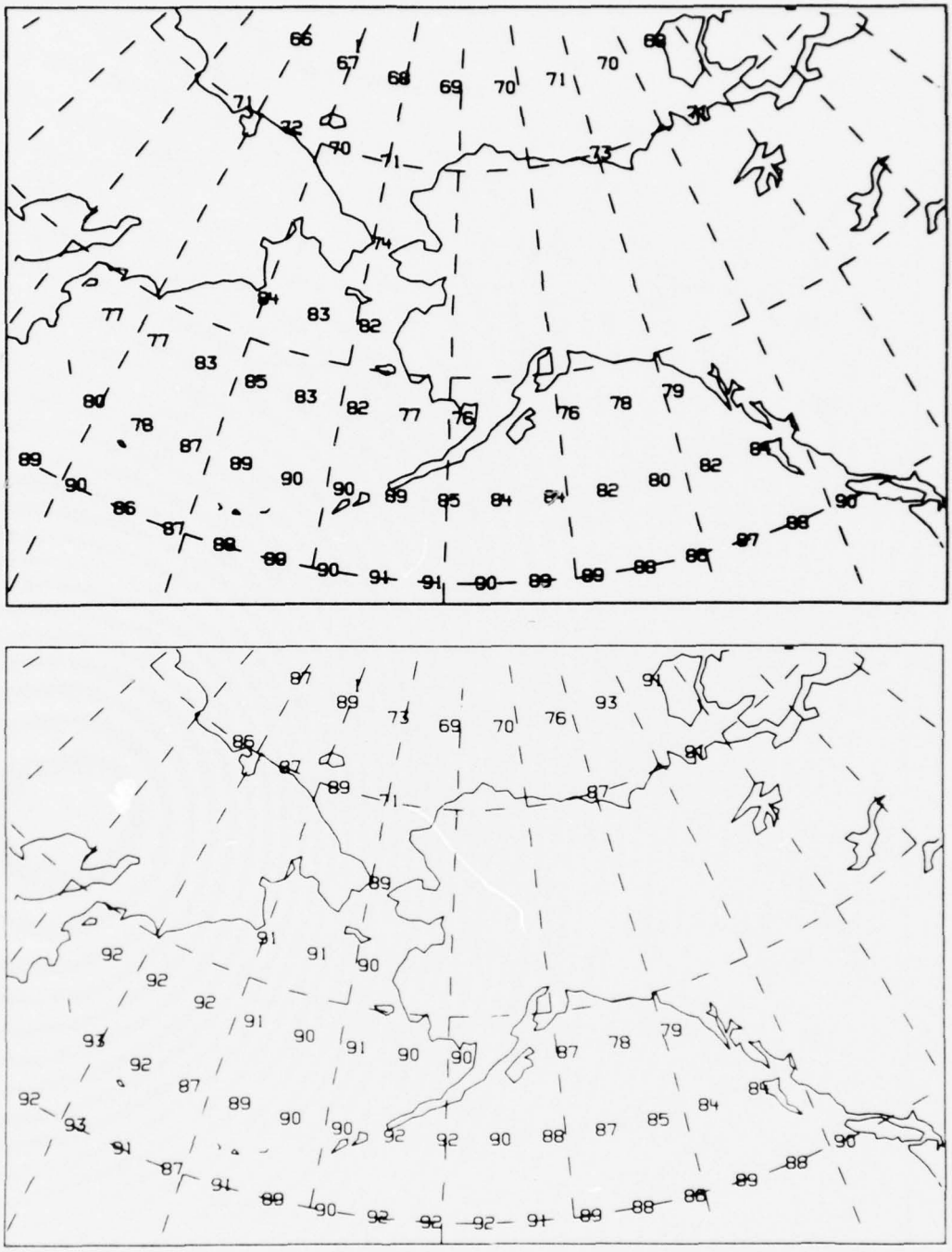

Figure 37. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 4 MHz, winter night and high solar activity.

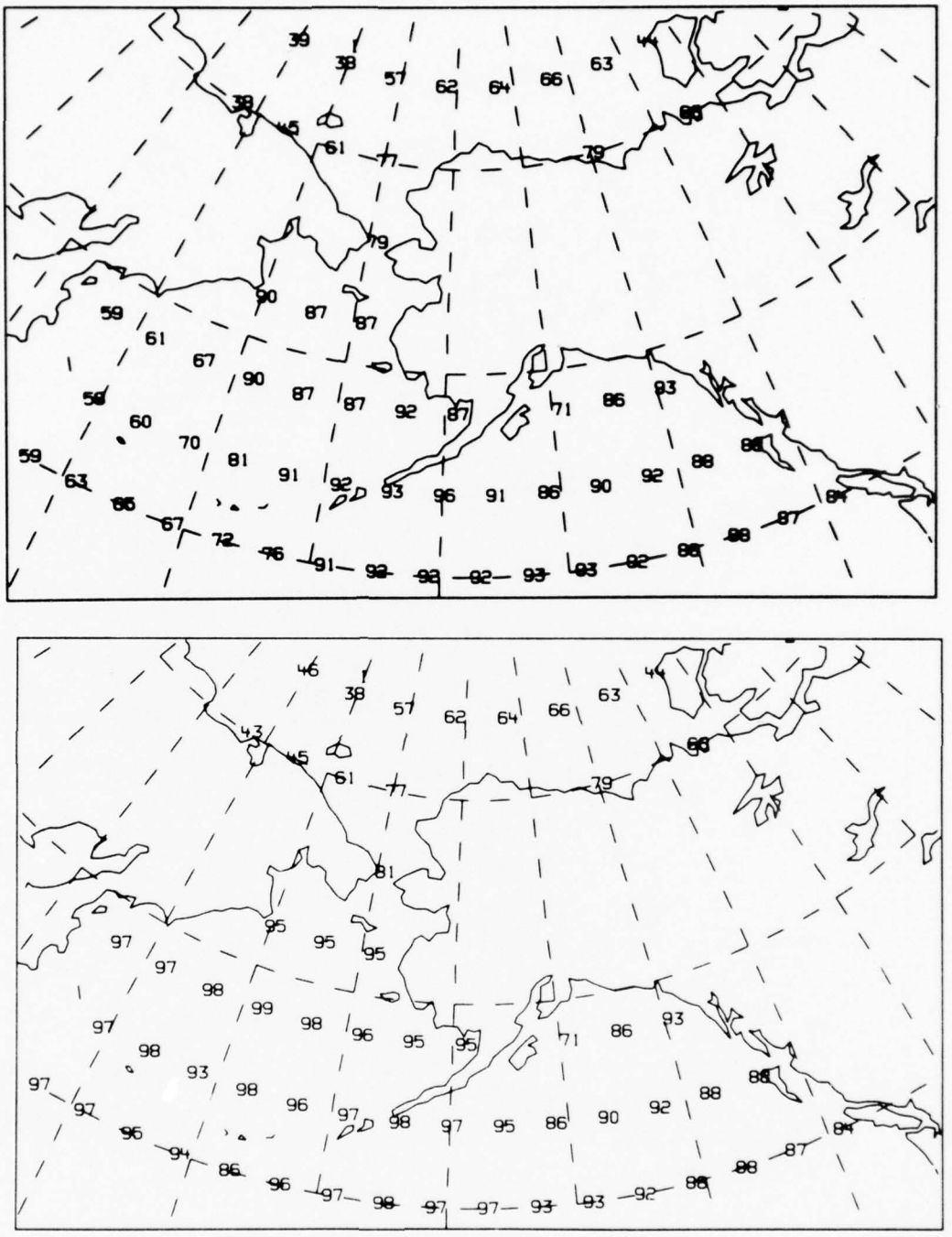

Figure 38. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak, 4, 6 and 8 MHz, summer day and low solar activity.

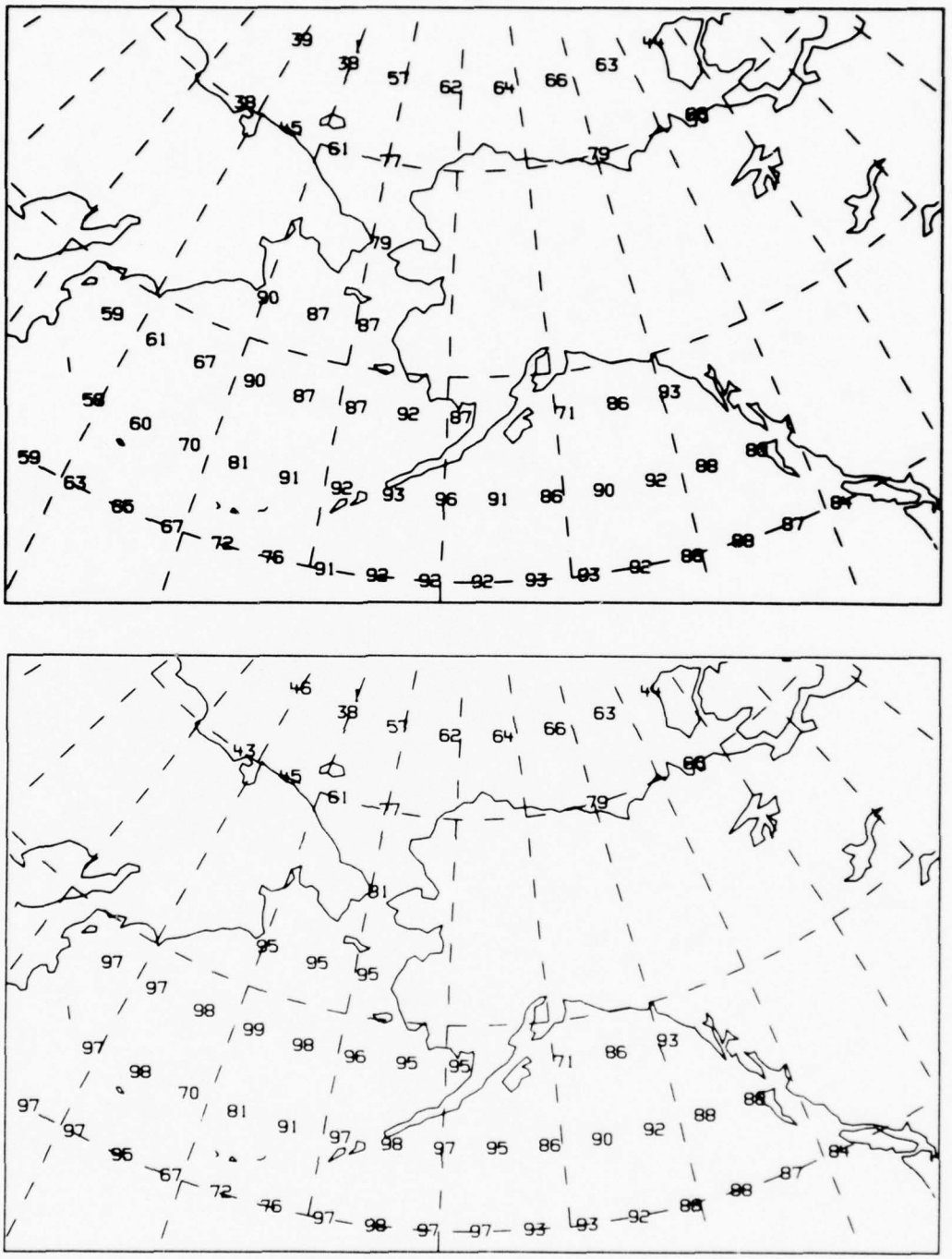

Figure 39. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak, 6 and 8 MHz, summer day and low solar activity.

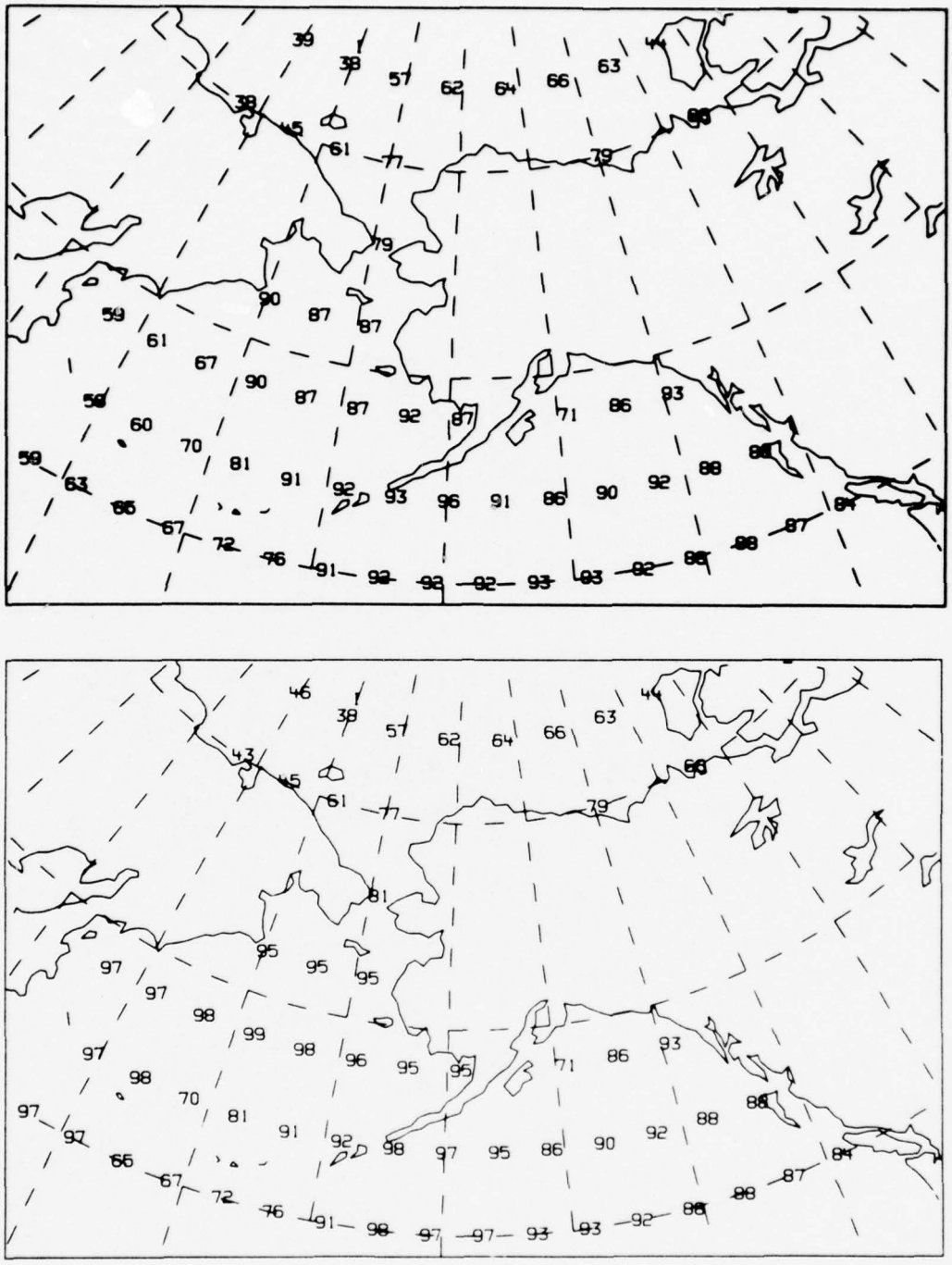

Figure 40. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak, 8 MHz, summer day and low solar activity.

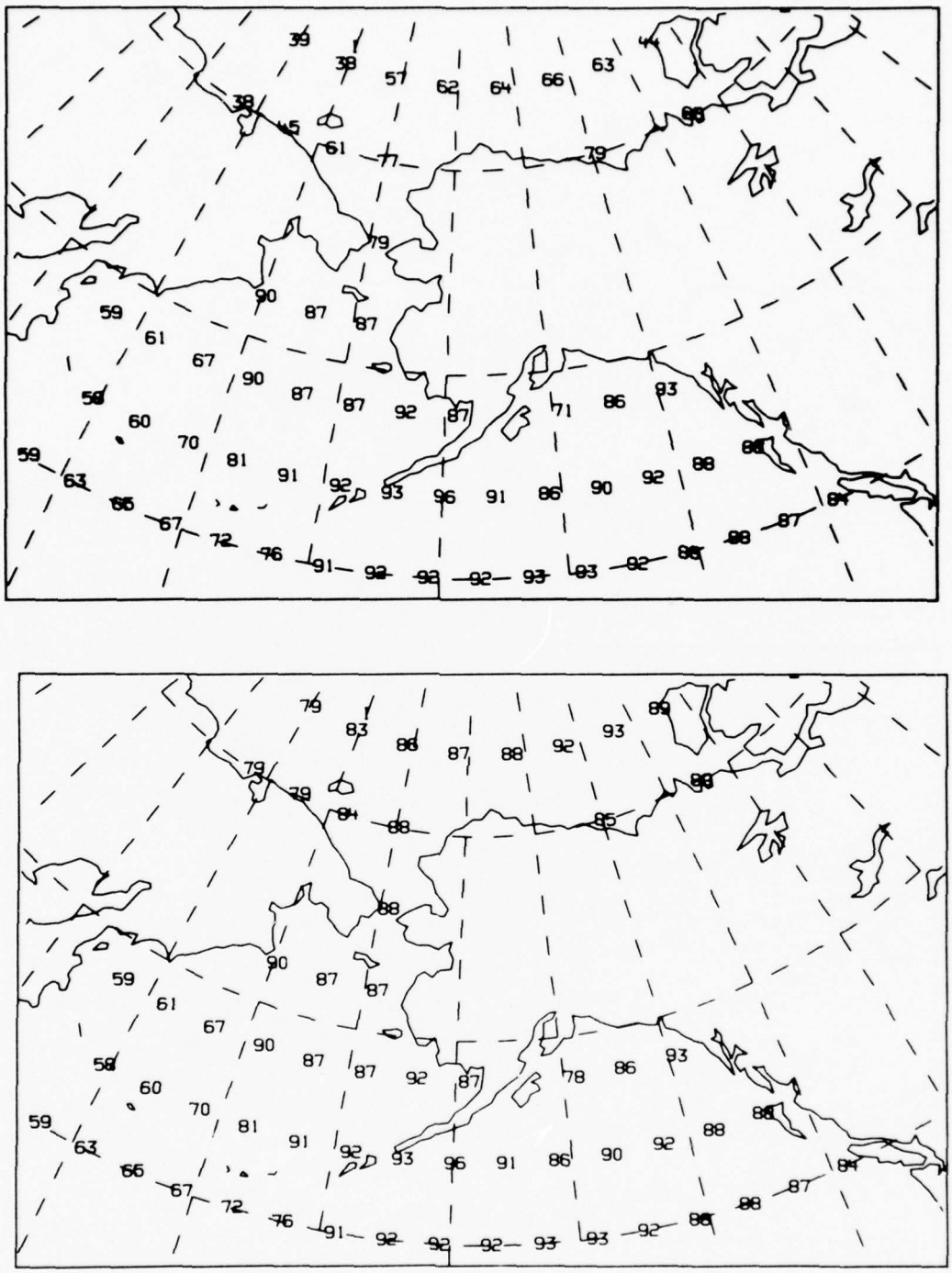

Figure 41. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 4, 6 and 8 MHz, summer day and low solar activity.

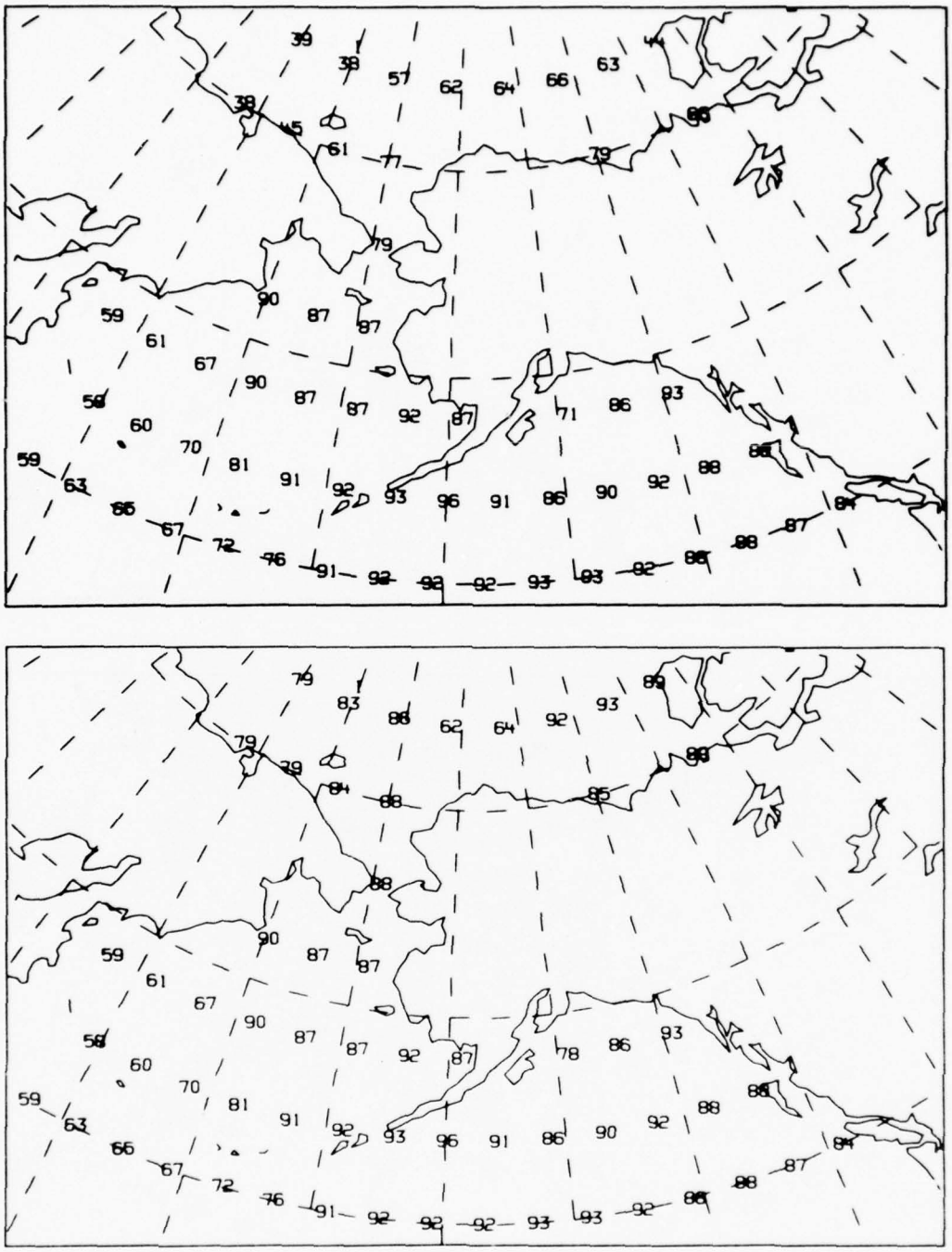

Figure 42. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 6 and 8 MHz, summer day and low solar activity.

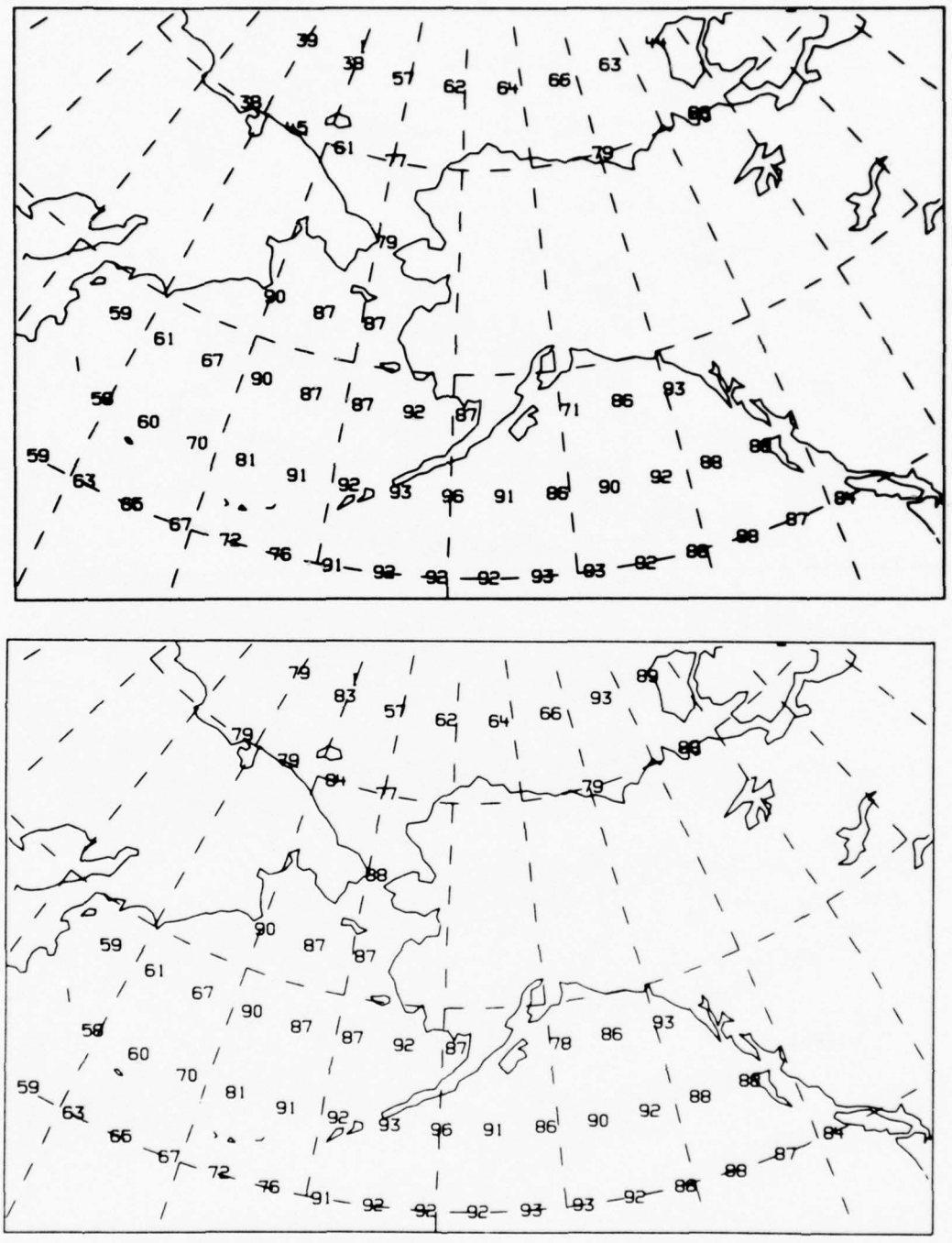

Figure 43. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 8 MHz, summer day and low solar activity.

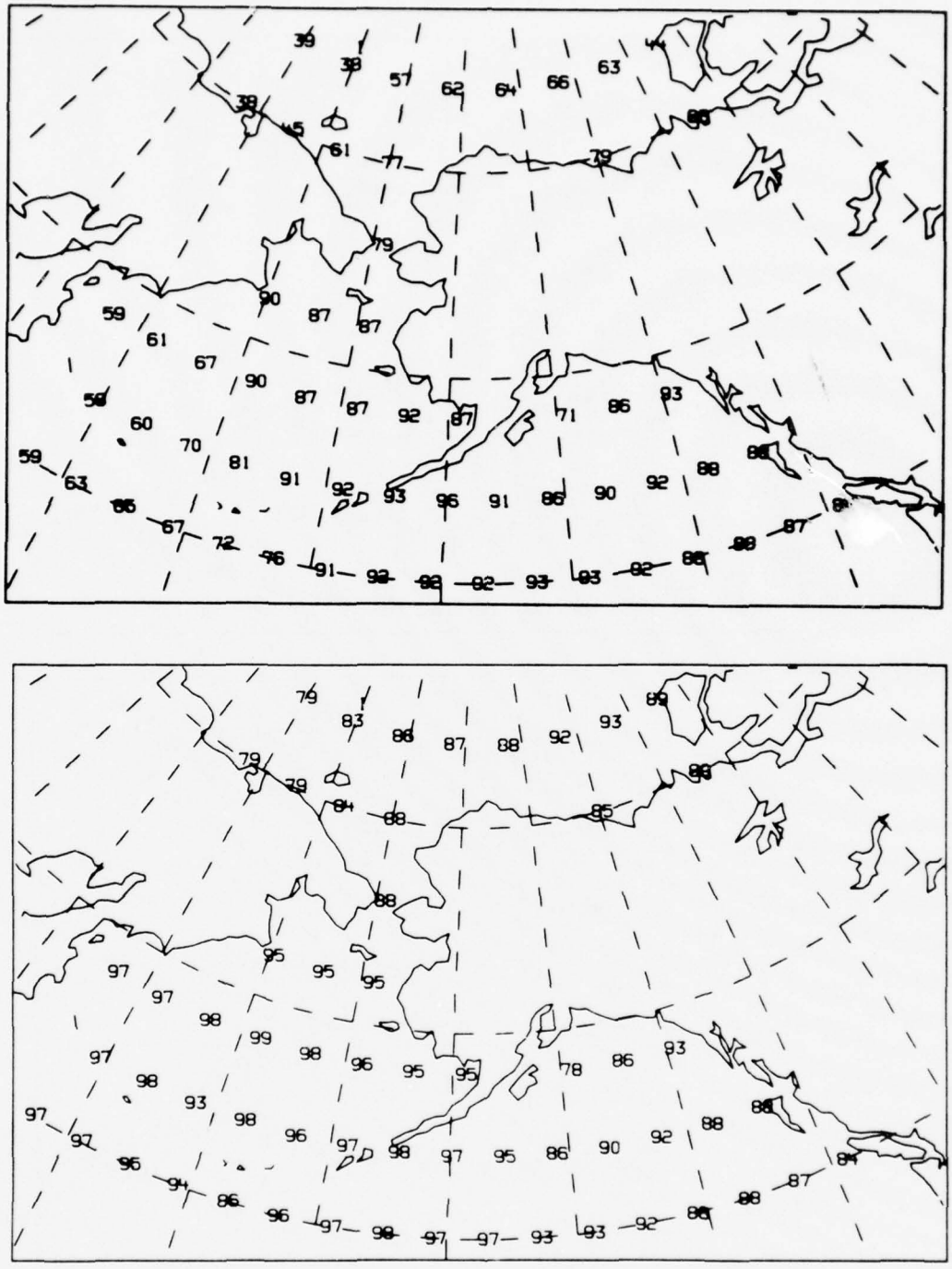

Figure 44. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 4, 6, and 8 MHz, summer day and low solar activity.

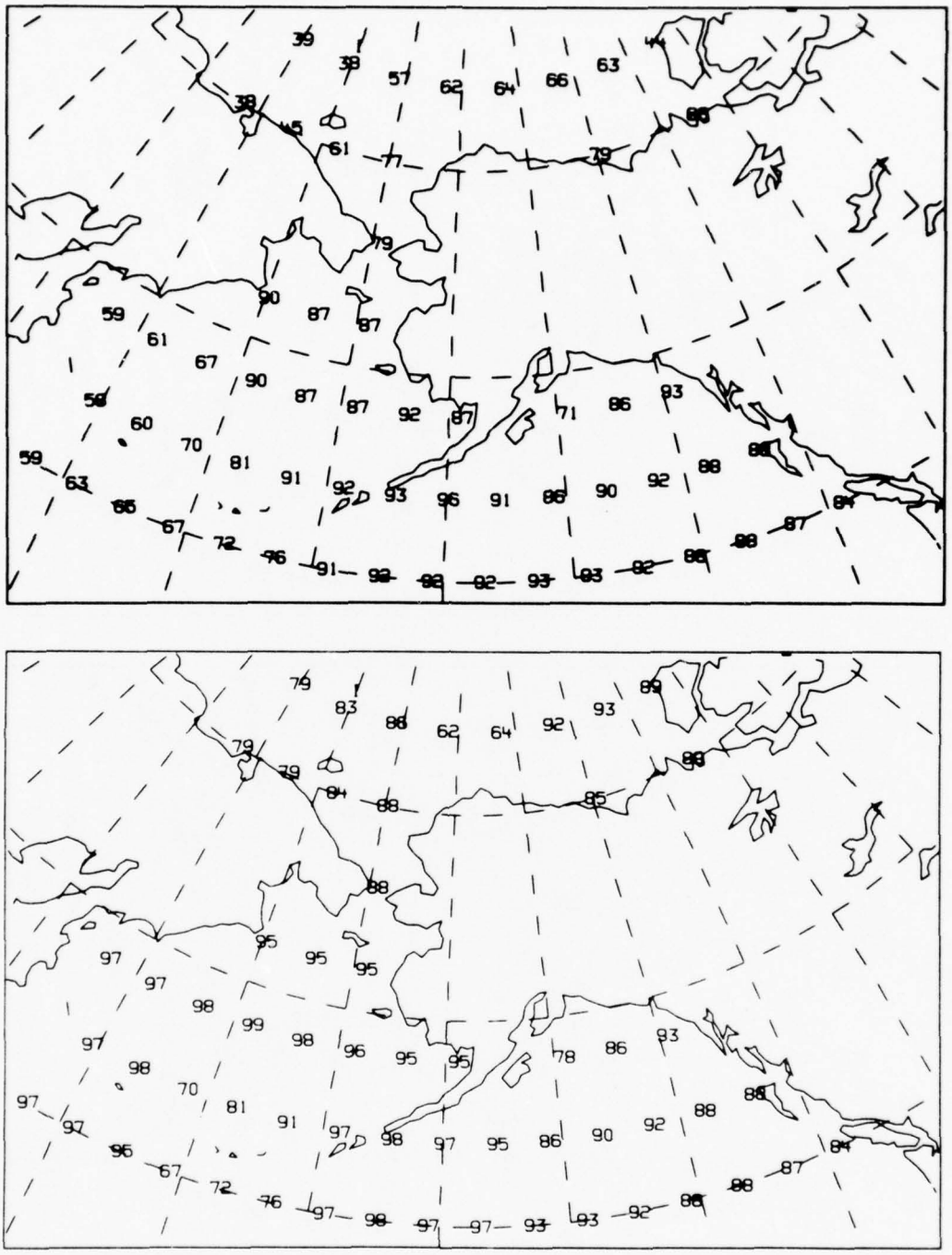

Figure 45. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 6 and 8 MHz, summer day and low solar activity.

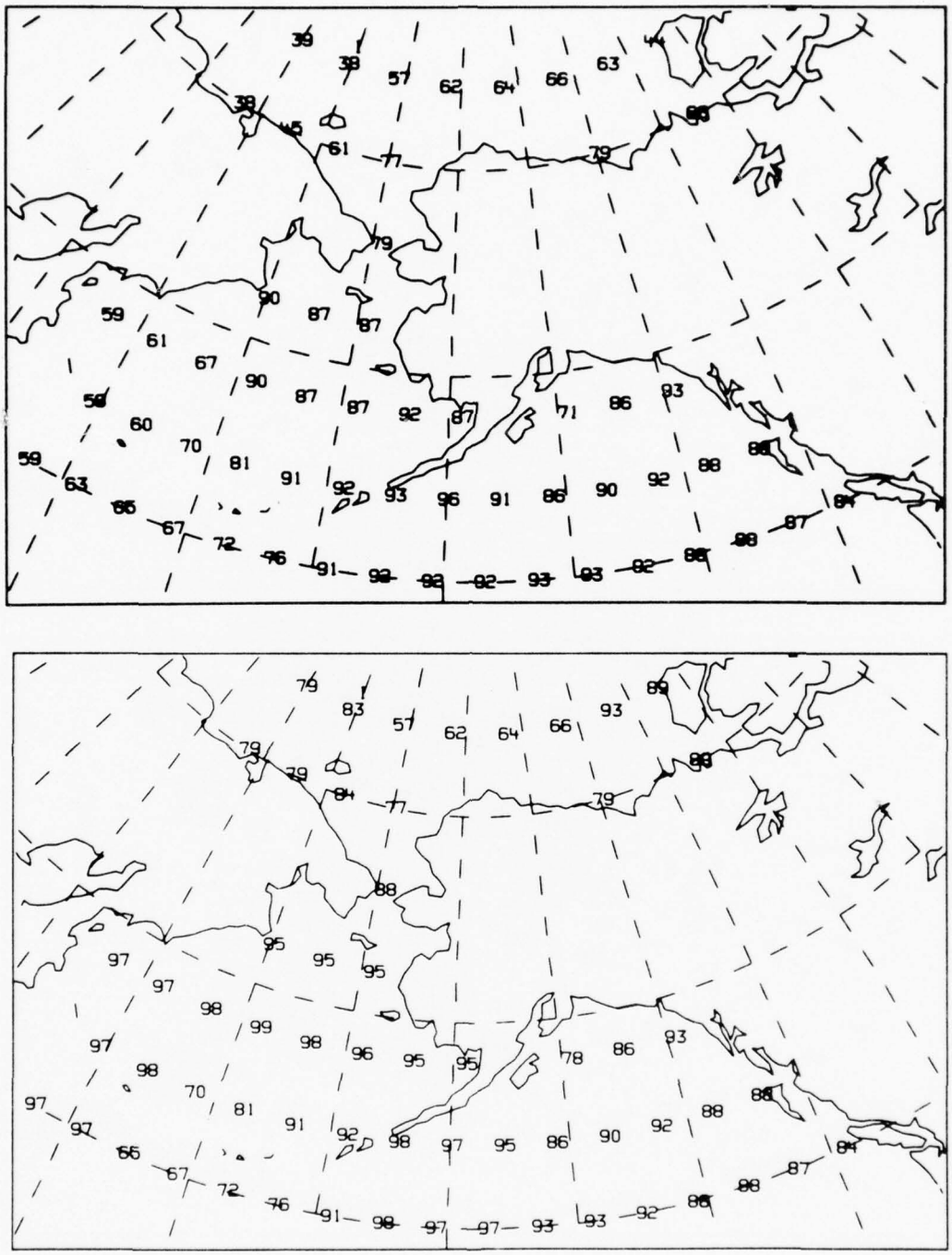

Figure 46. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 8 MHz, summer day and low solar activity.

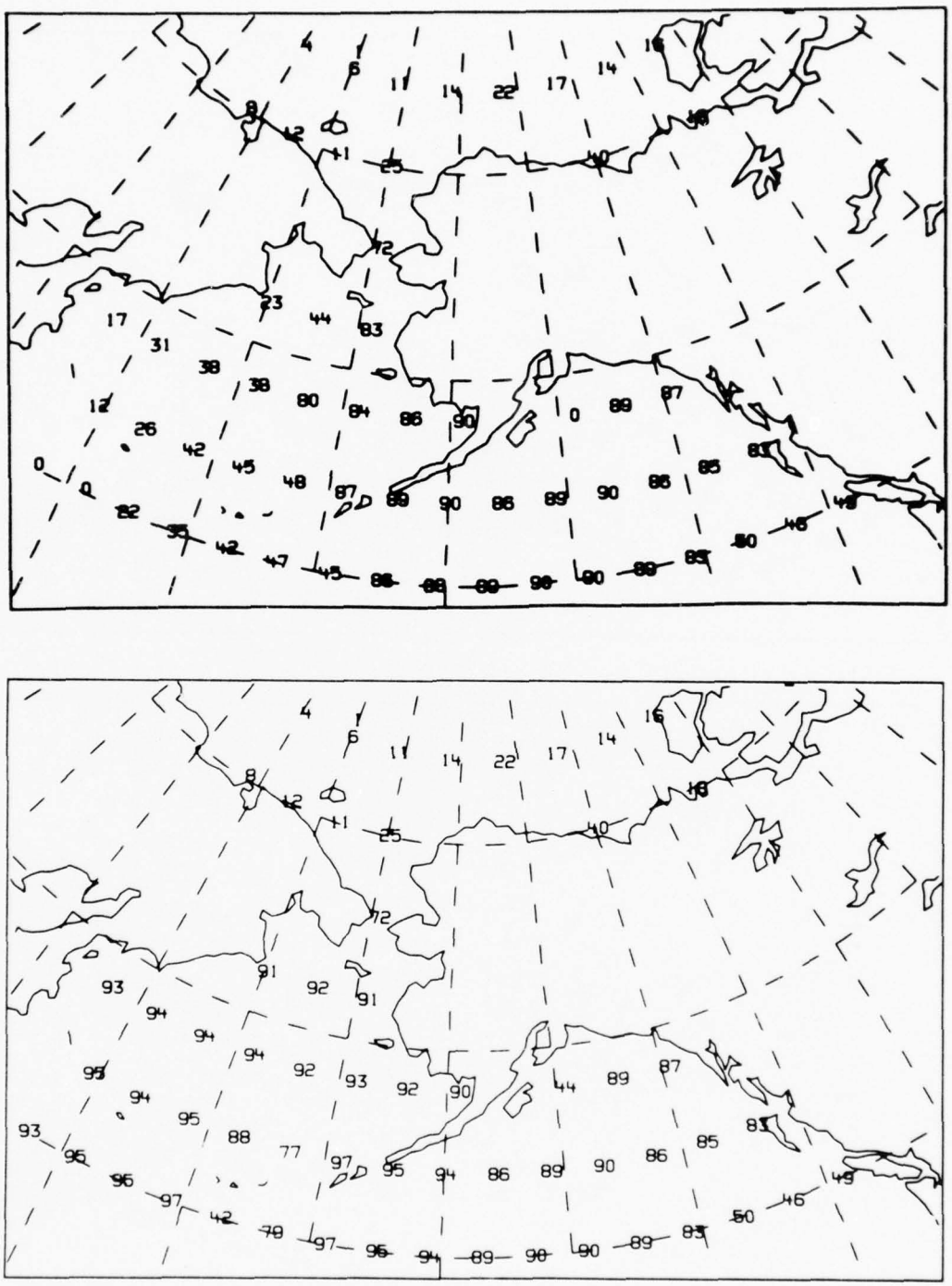

Figure 47. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak, 4, 6, and 8 MHz, summer day and high solar activity.

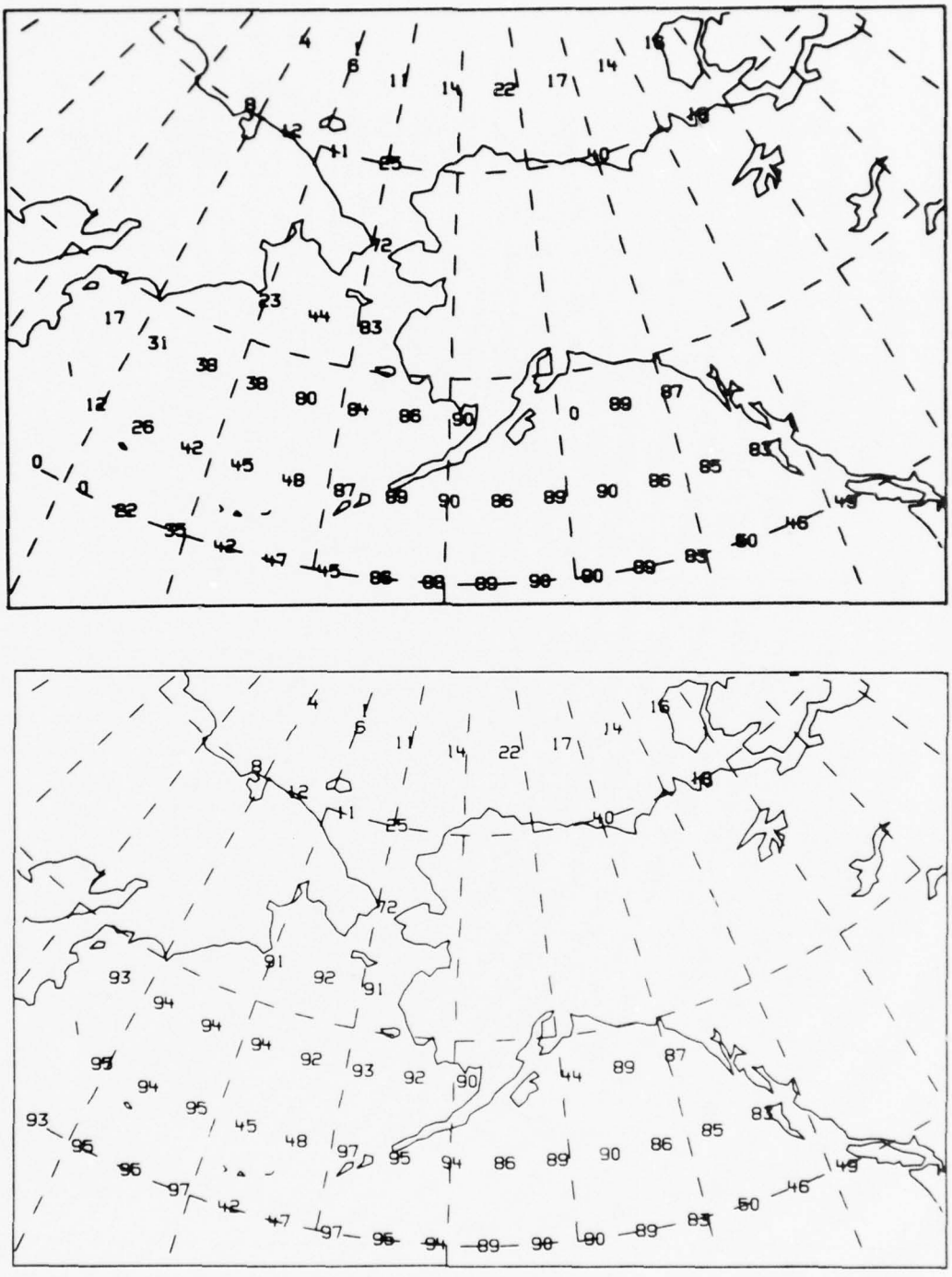

Figure 48. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak, 6 and 8 MHz, summer day and high solar activity.

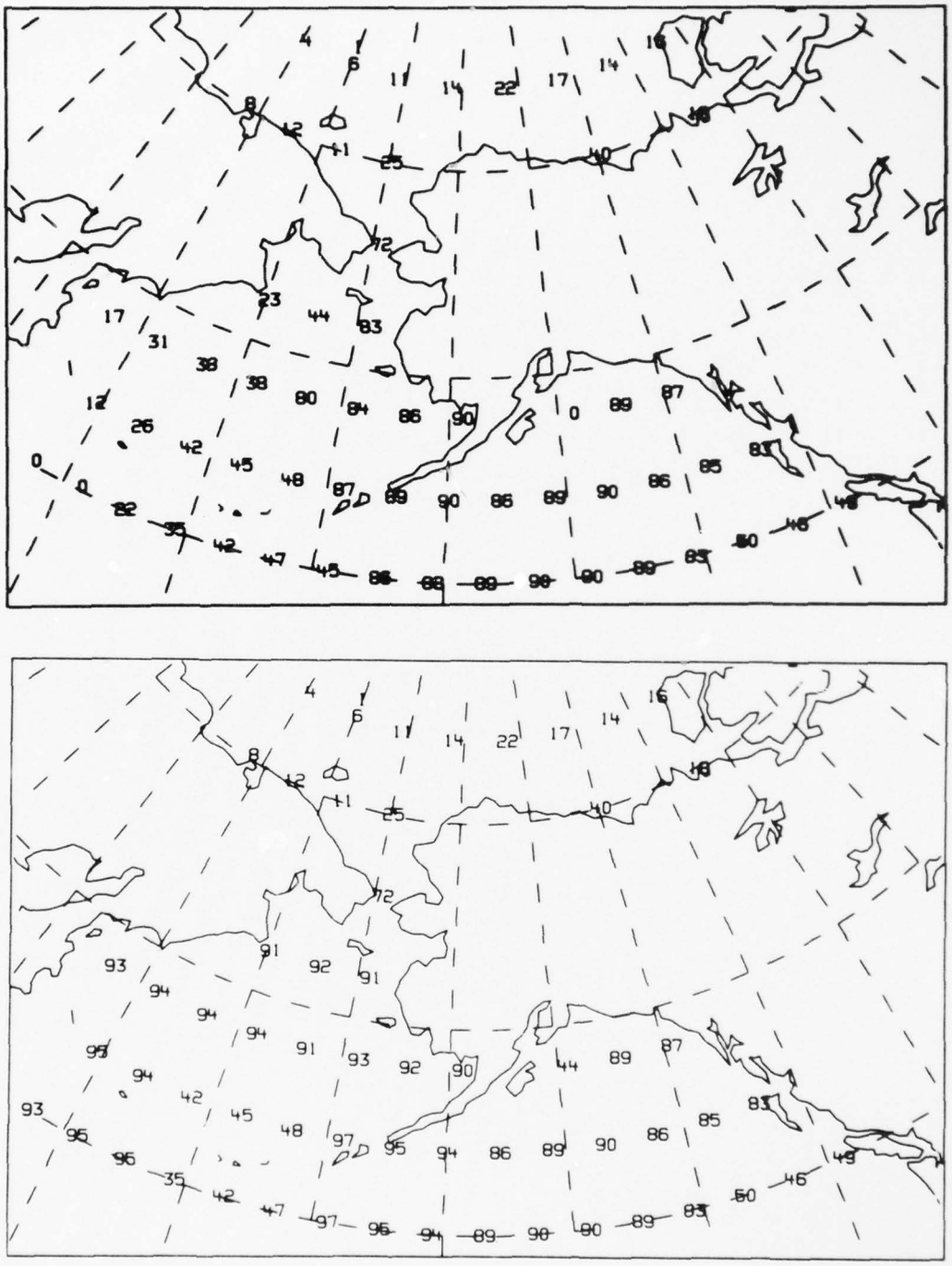

Figure 49. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak, 8 MHz, summer day and high solar activity.

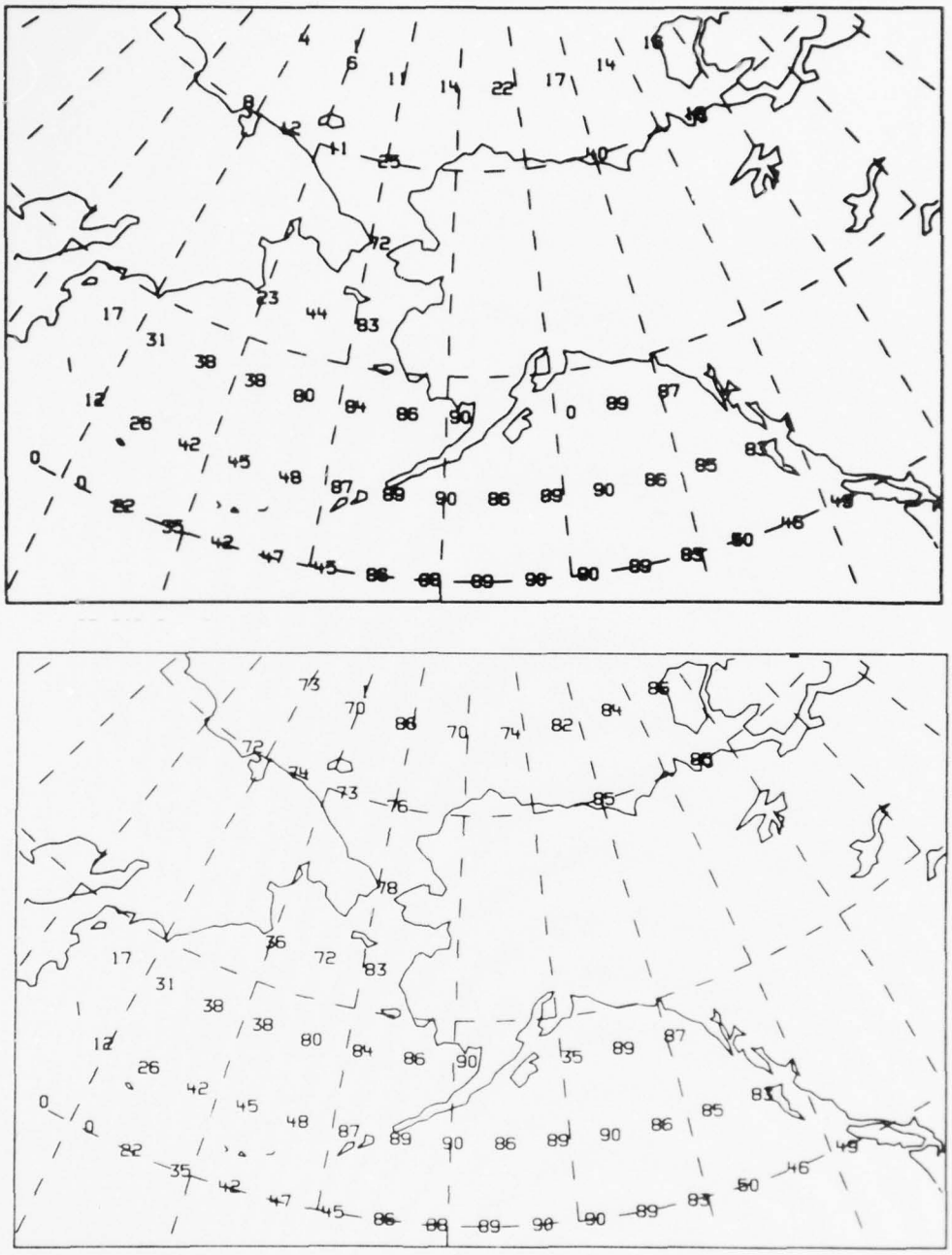

Figure 50. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 4, 6 and 8 MHz, summer day and high solar activity.

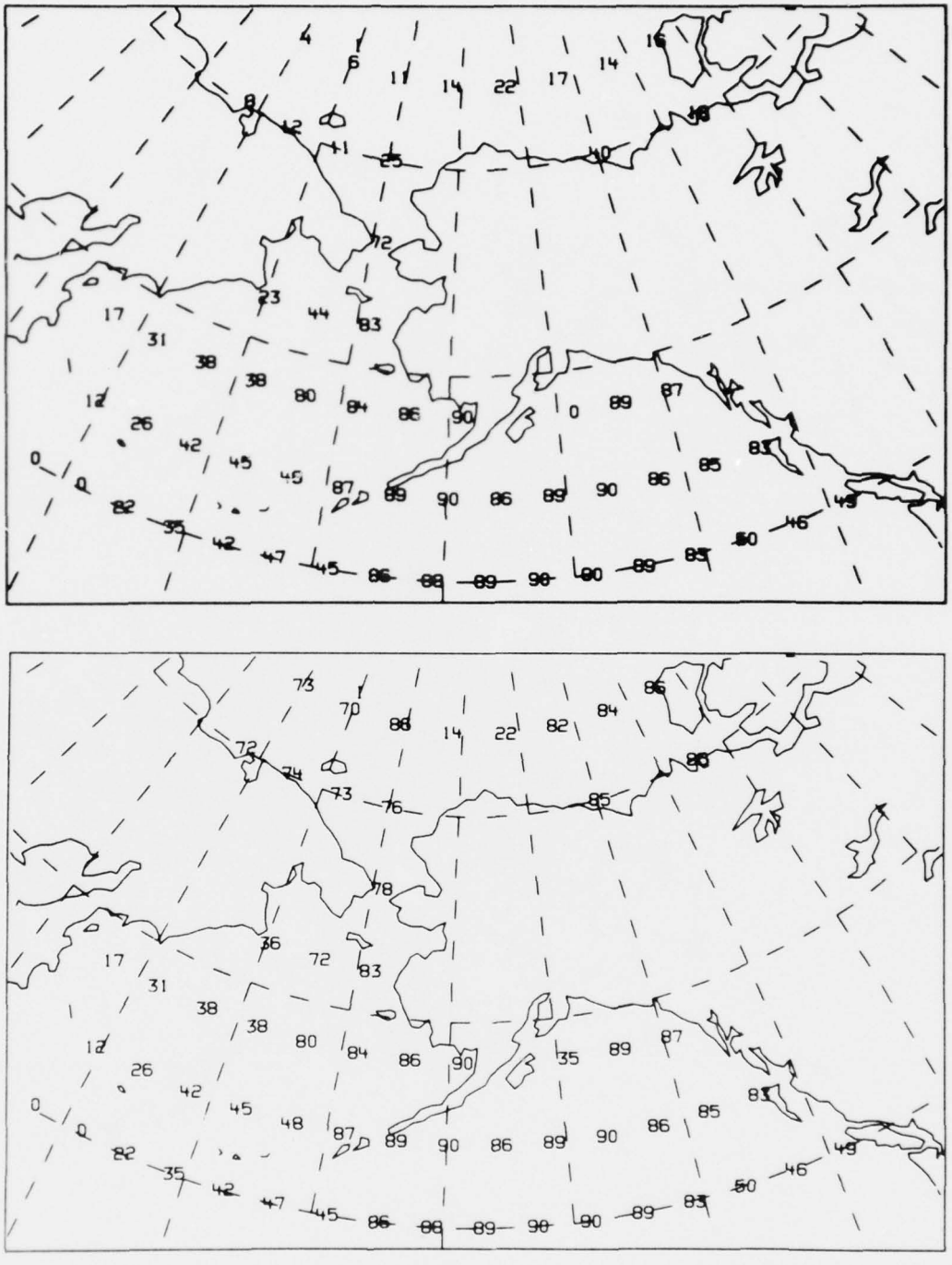

Figure 51. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 6 and 8 MHz, summer day and high solar activity.

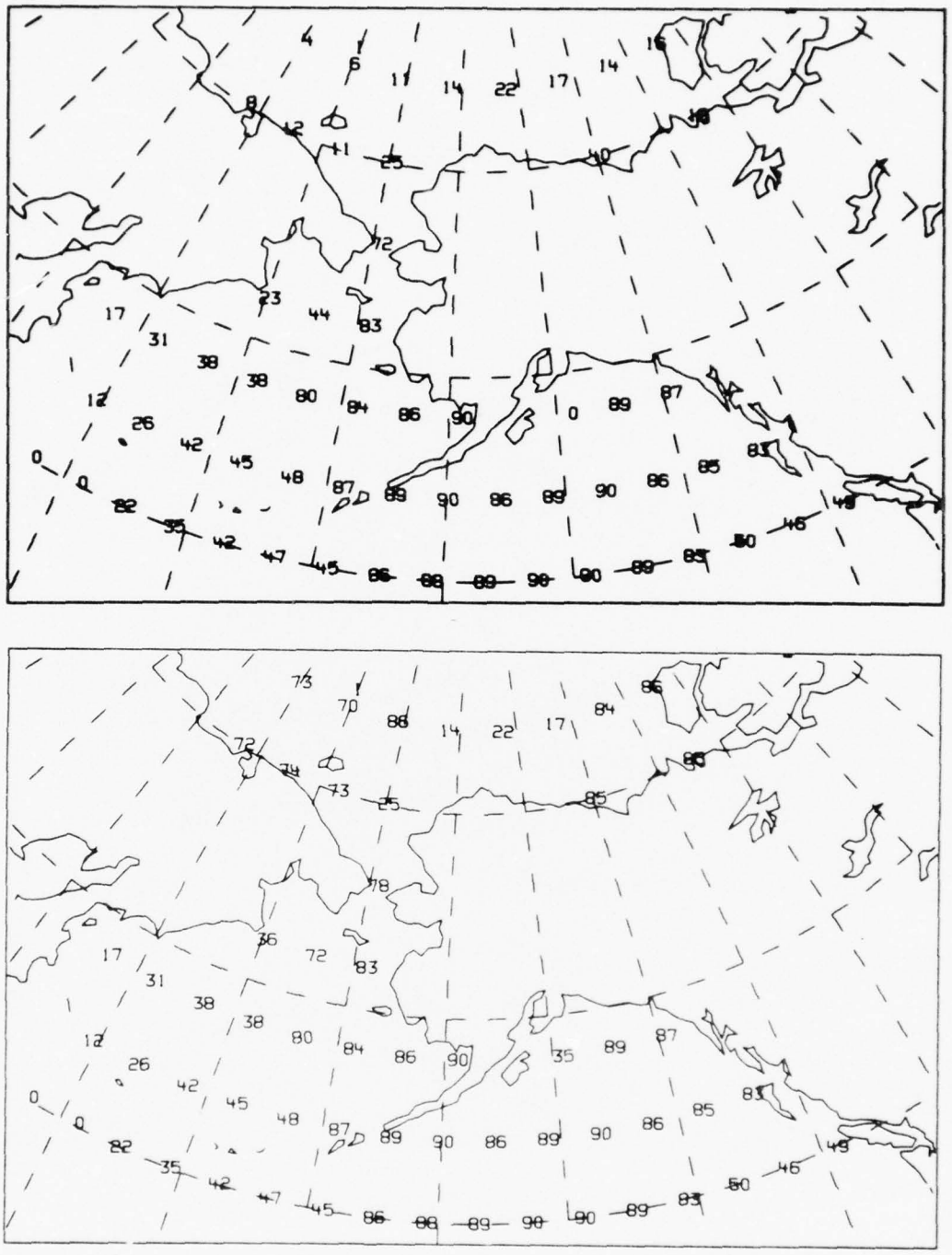

Figure 52. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 8 MHz, summer day and high solar activity.

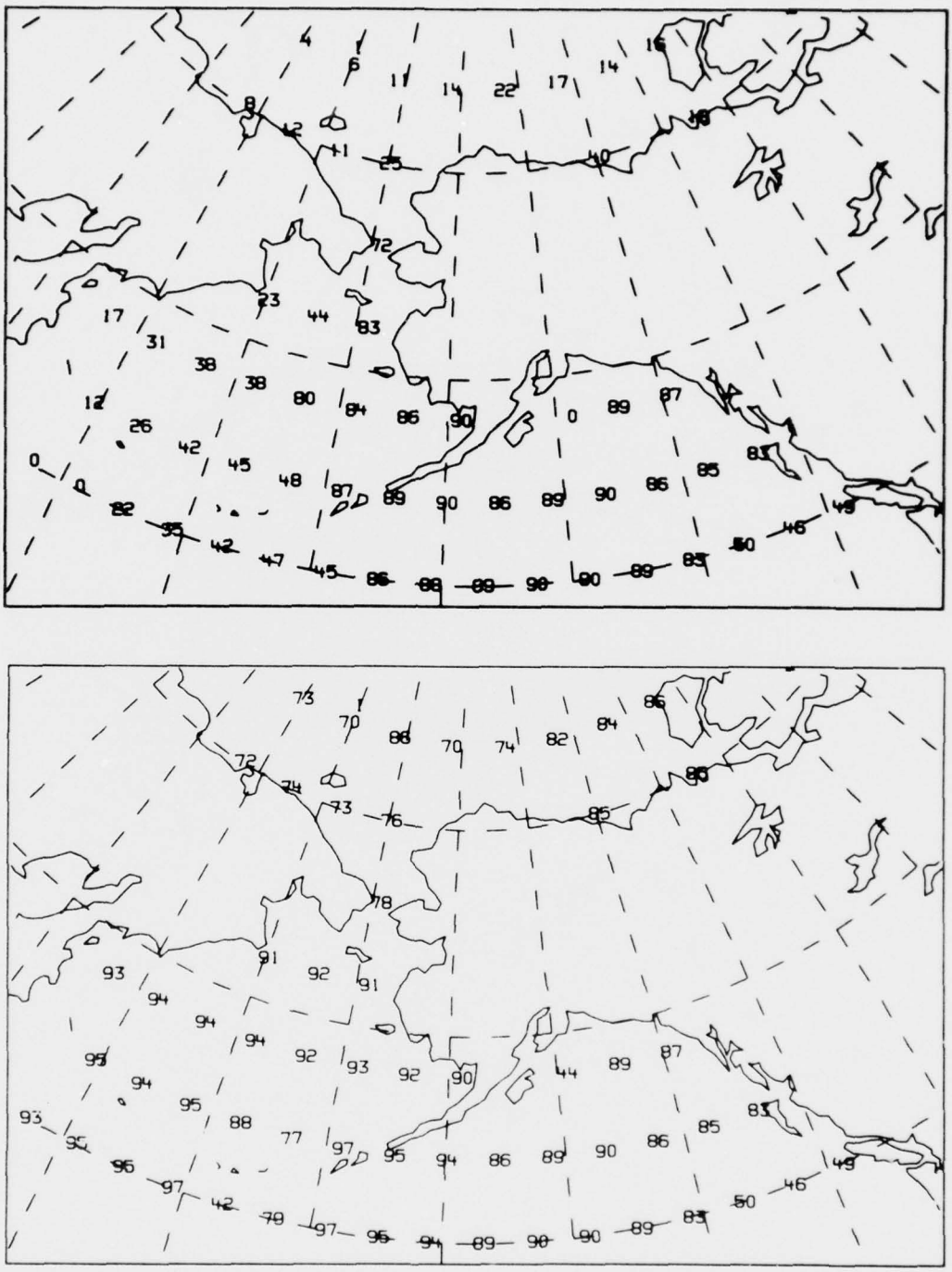

Figure 53. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 4, 6, and 8 MHz, summer day and high solar activity.

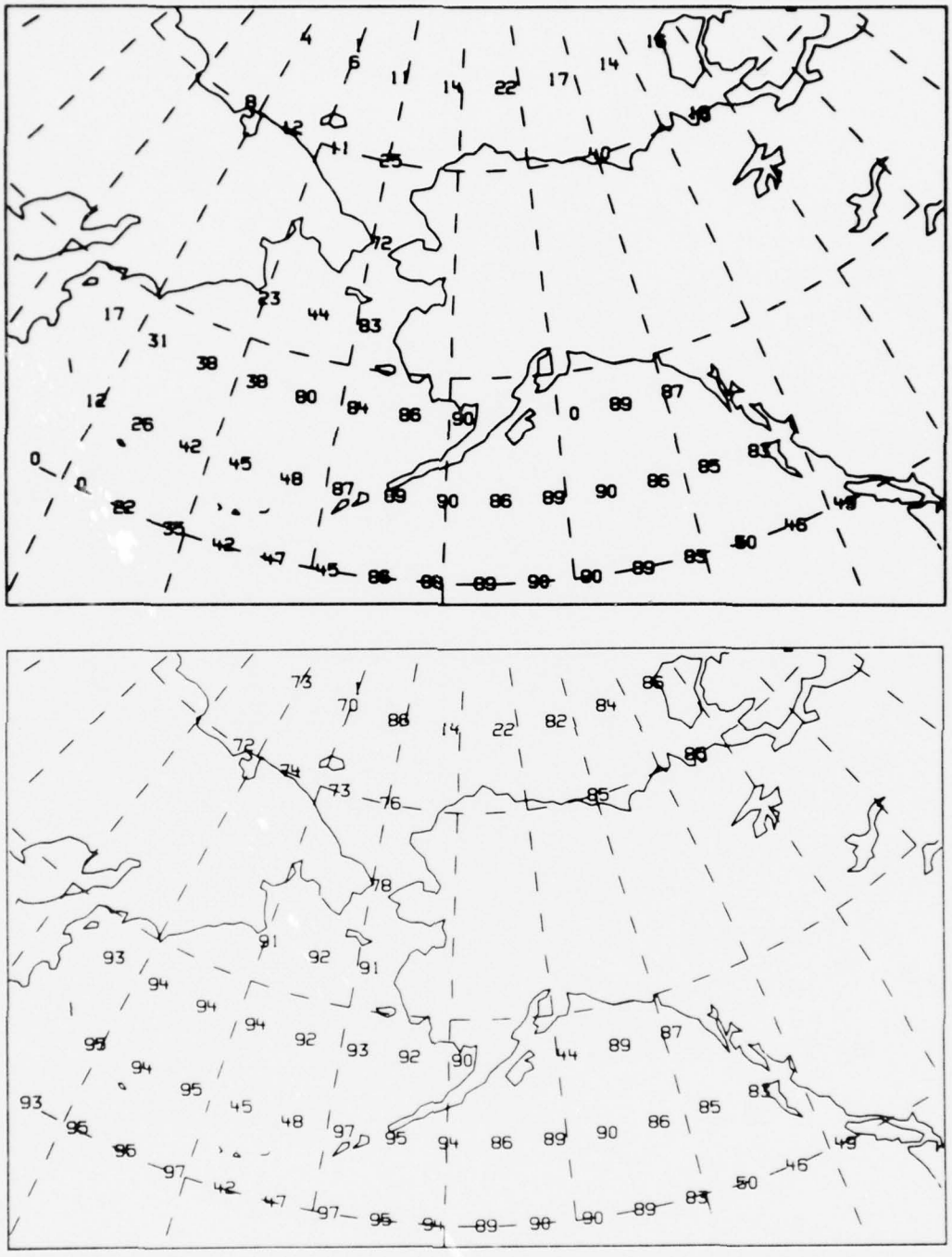

Figure 54. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 6 and 8 MHz, summer day and high solar activity.

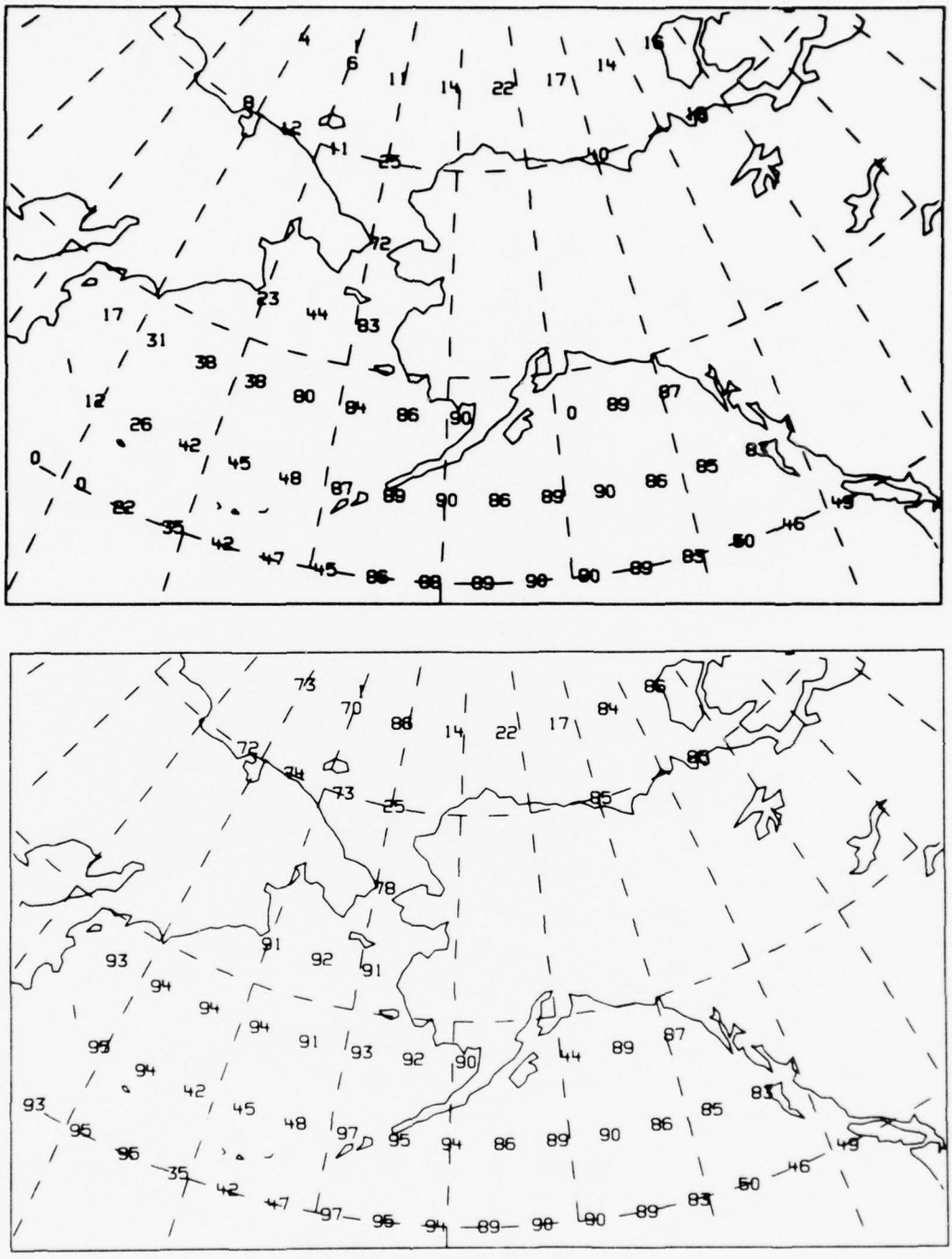

Figure 55. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 8 MHz, summer day and high solar activity.

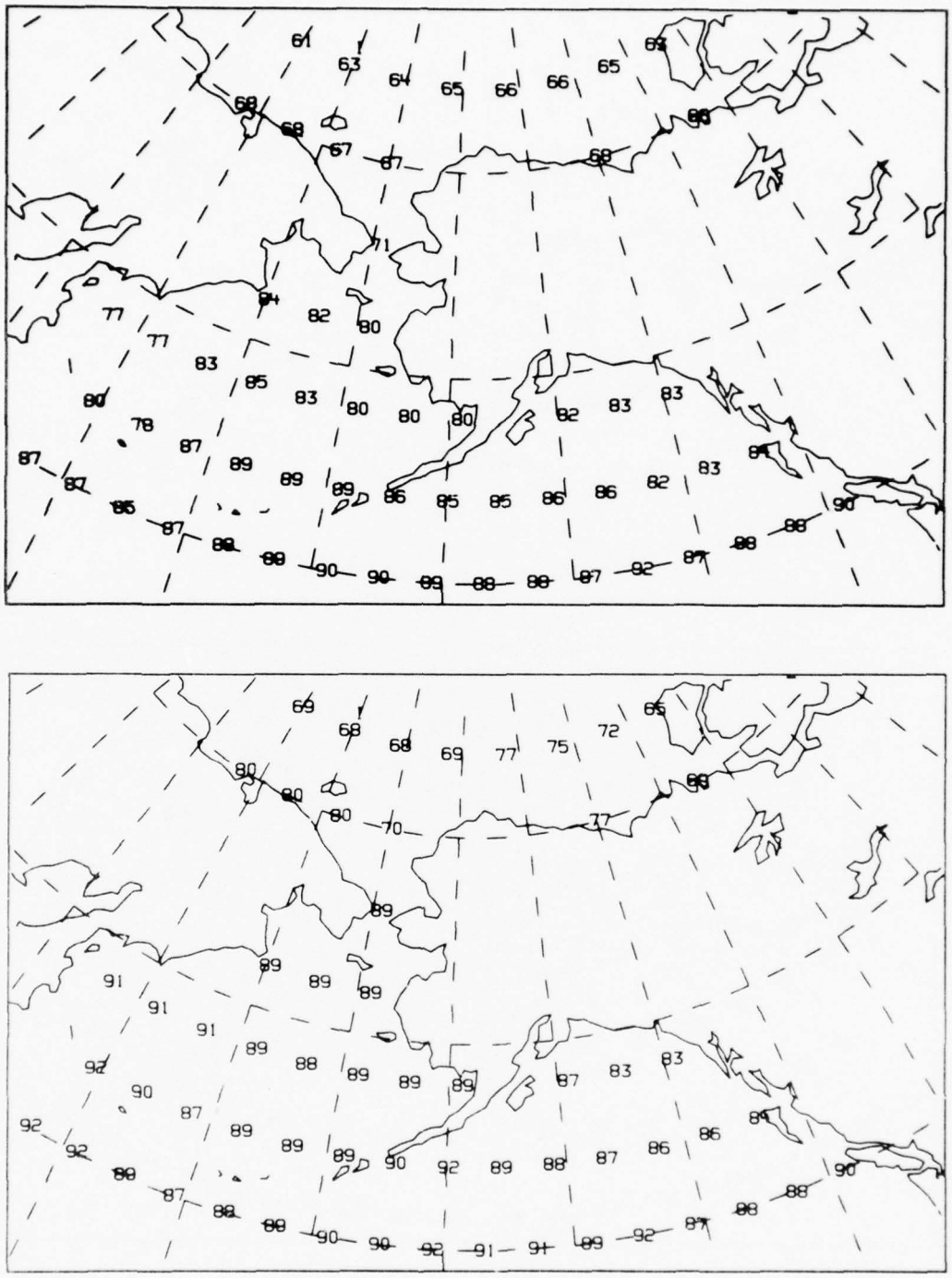

Figure 56. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak, 4, 6, and 8 MHz, summer night and low solar activity.

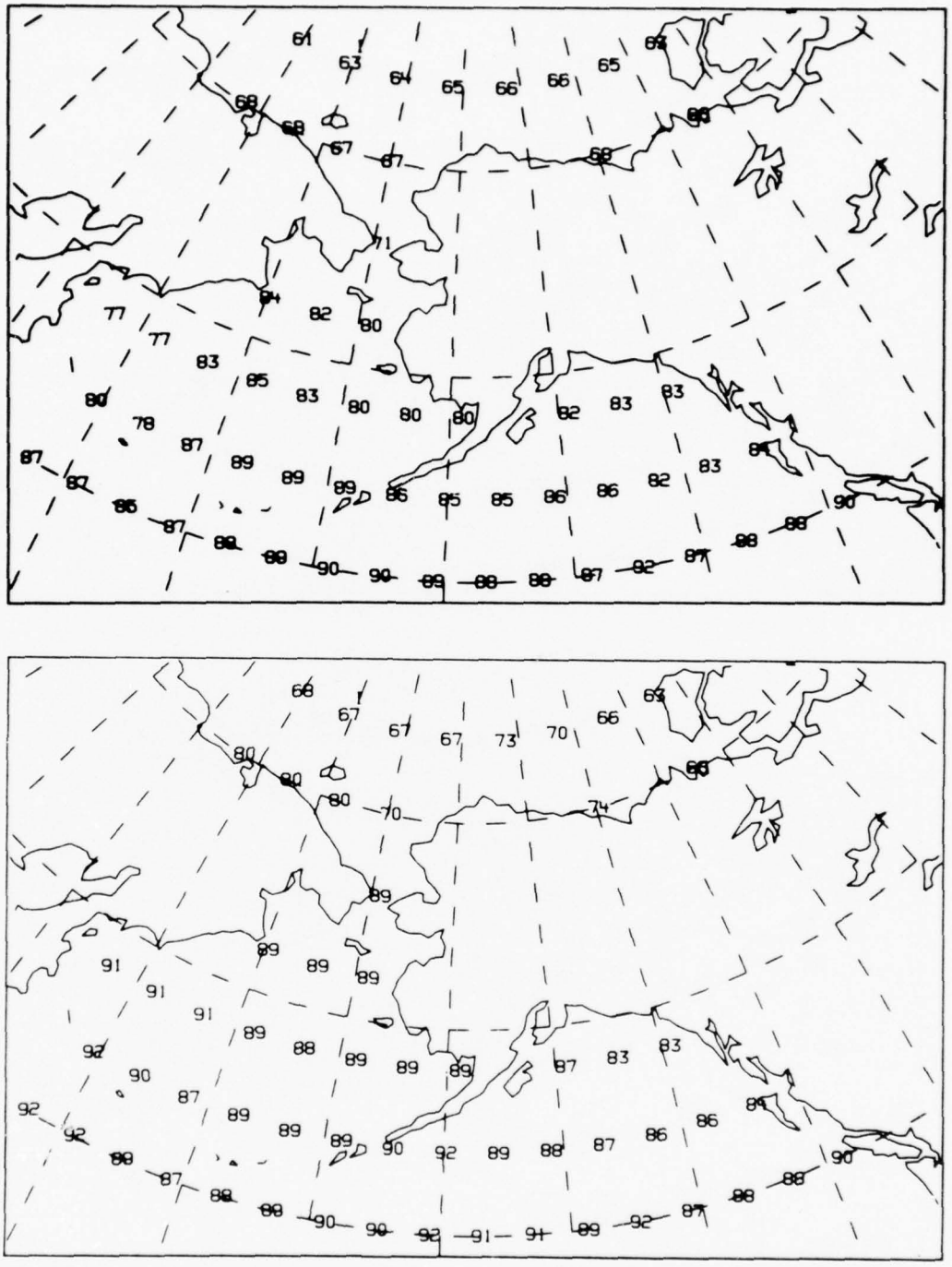

Figure 57. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak, 4 and 6 MHz, summer night and low solar activity.

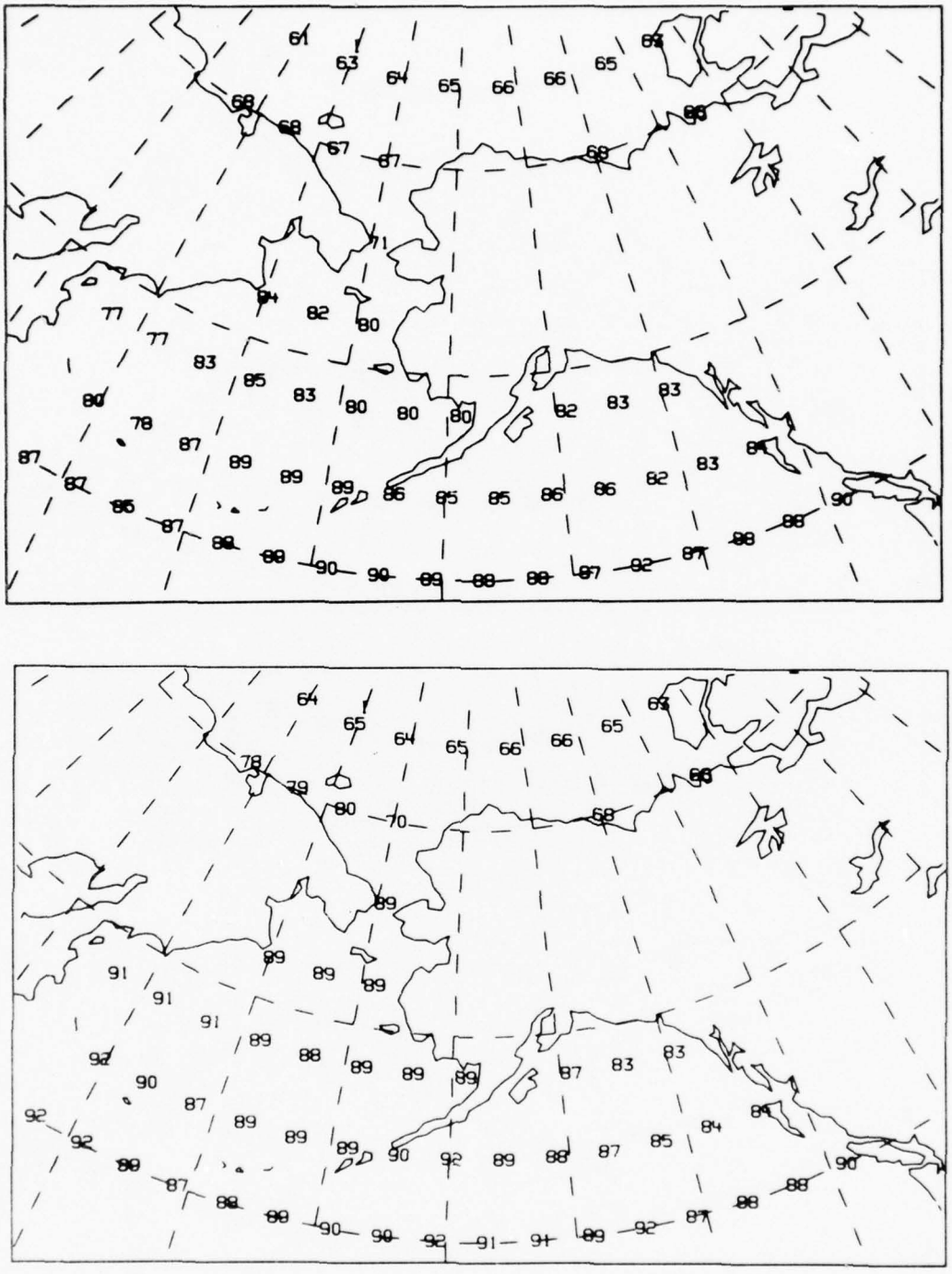

Figure 58. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak, 4 MHz, summer night and low solar activity.

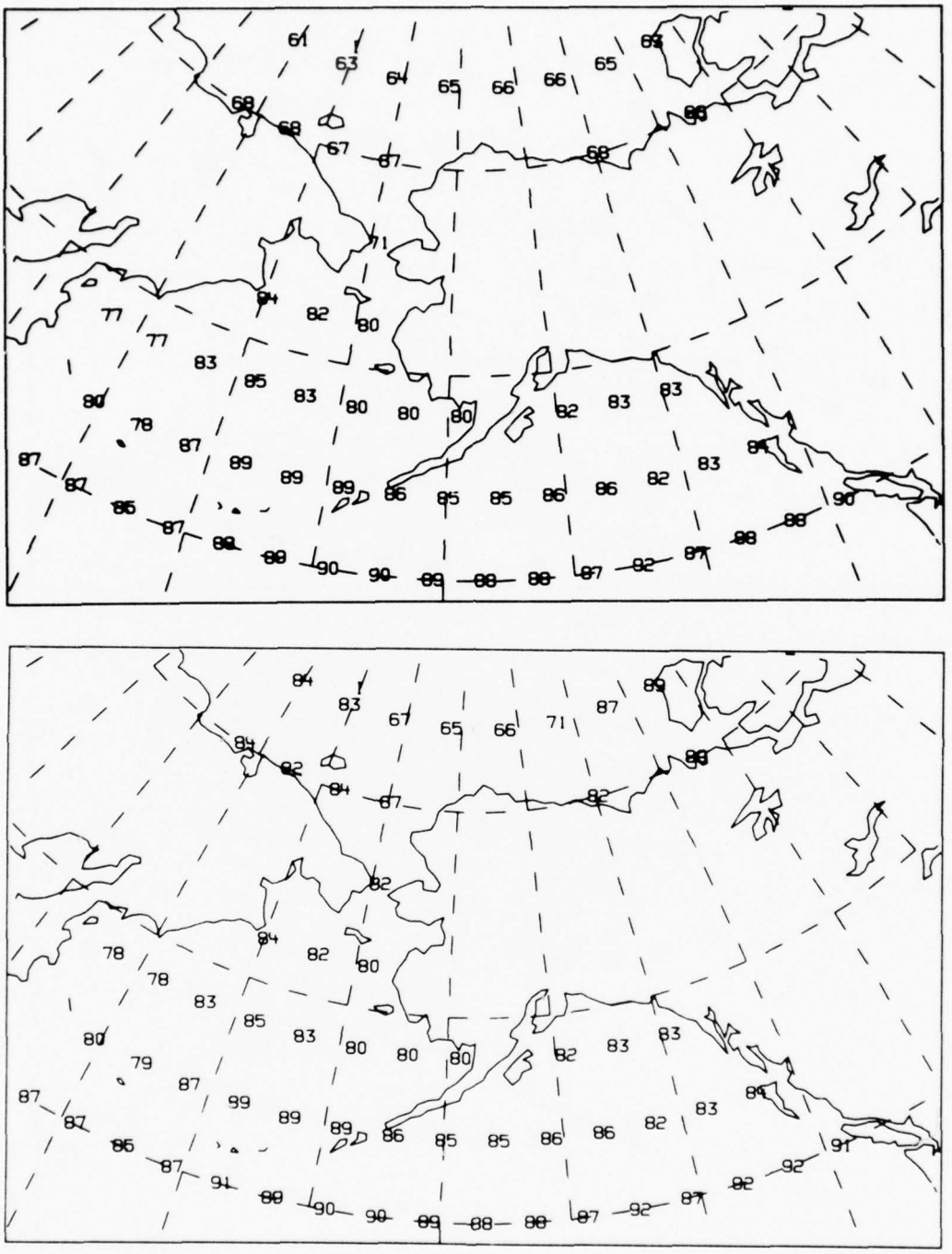

Figure 59. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 4, 6 and 8 MHz, summer night and low solar activity.

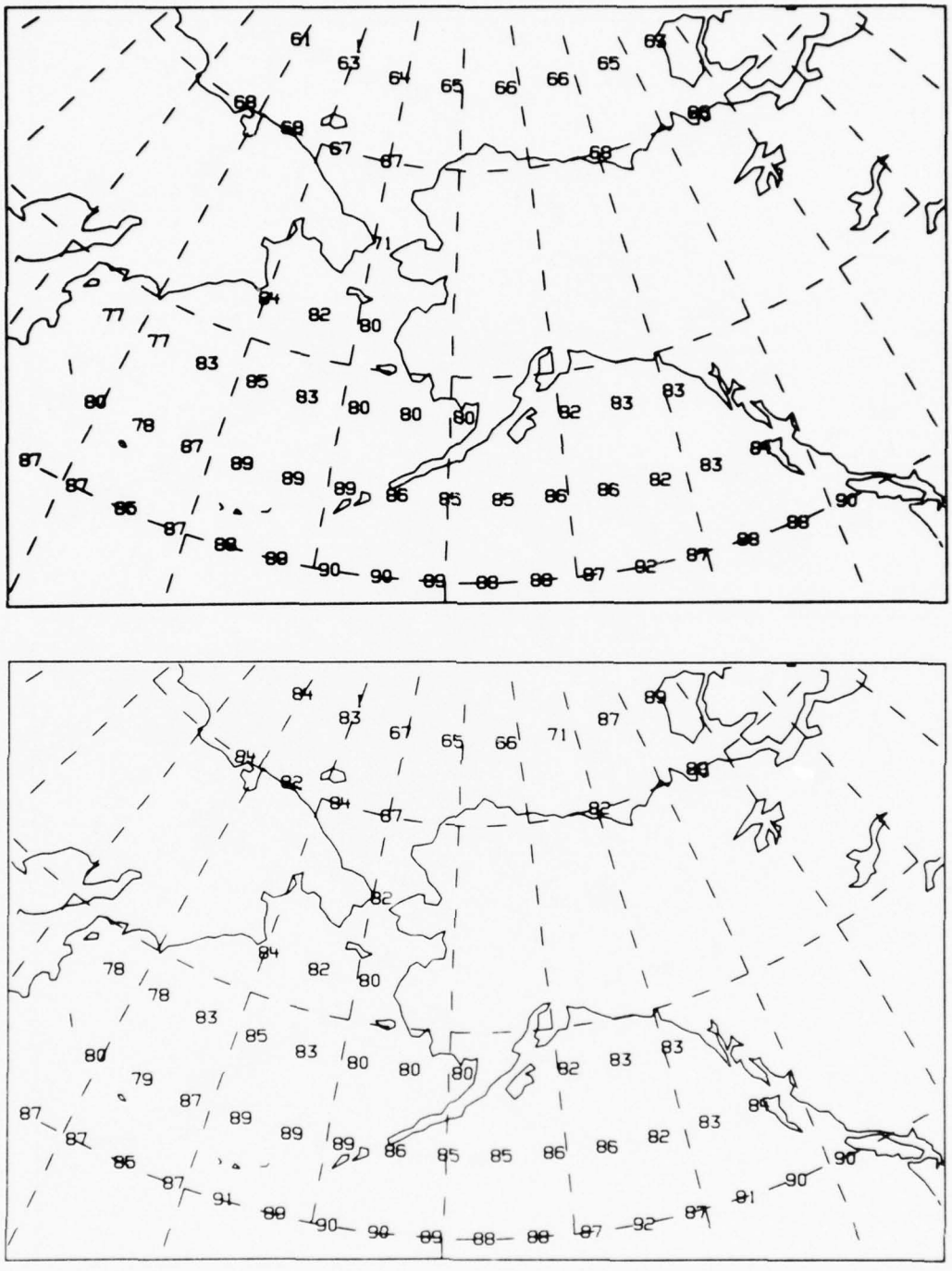

Figure 60. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 4 and 6 MHz, summer night and low solar activity.

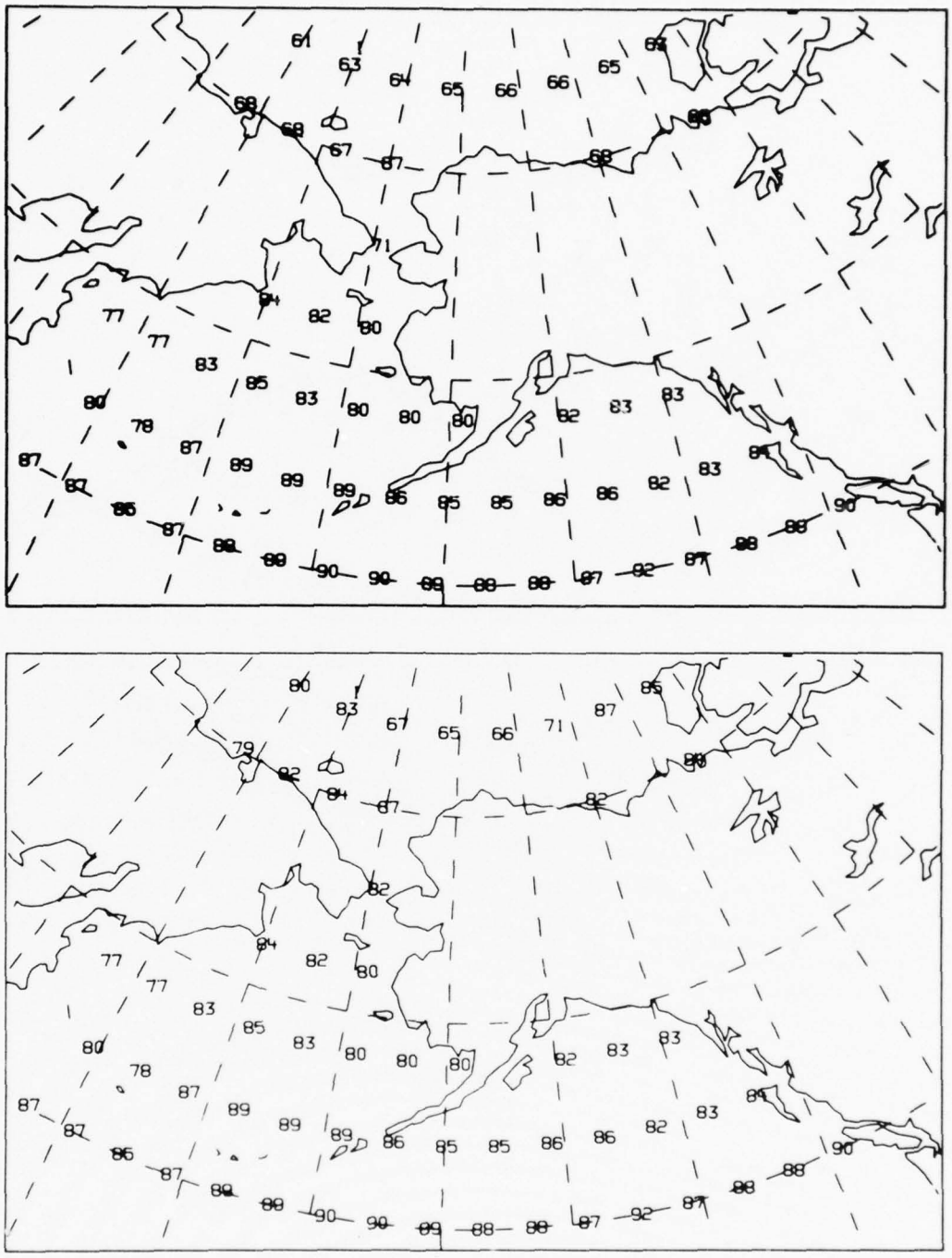

Figure 61. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 4 MHz, summer night and low solar activity.

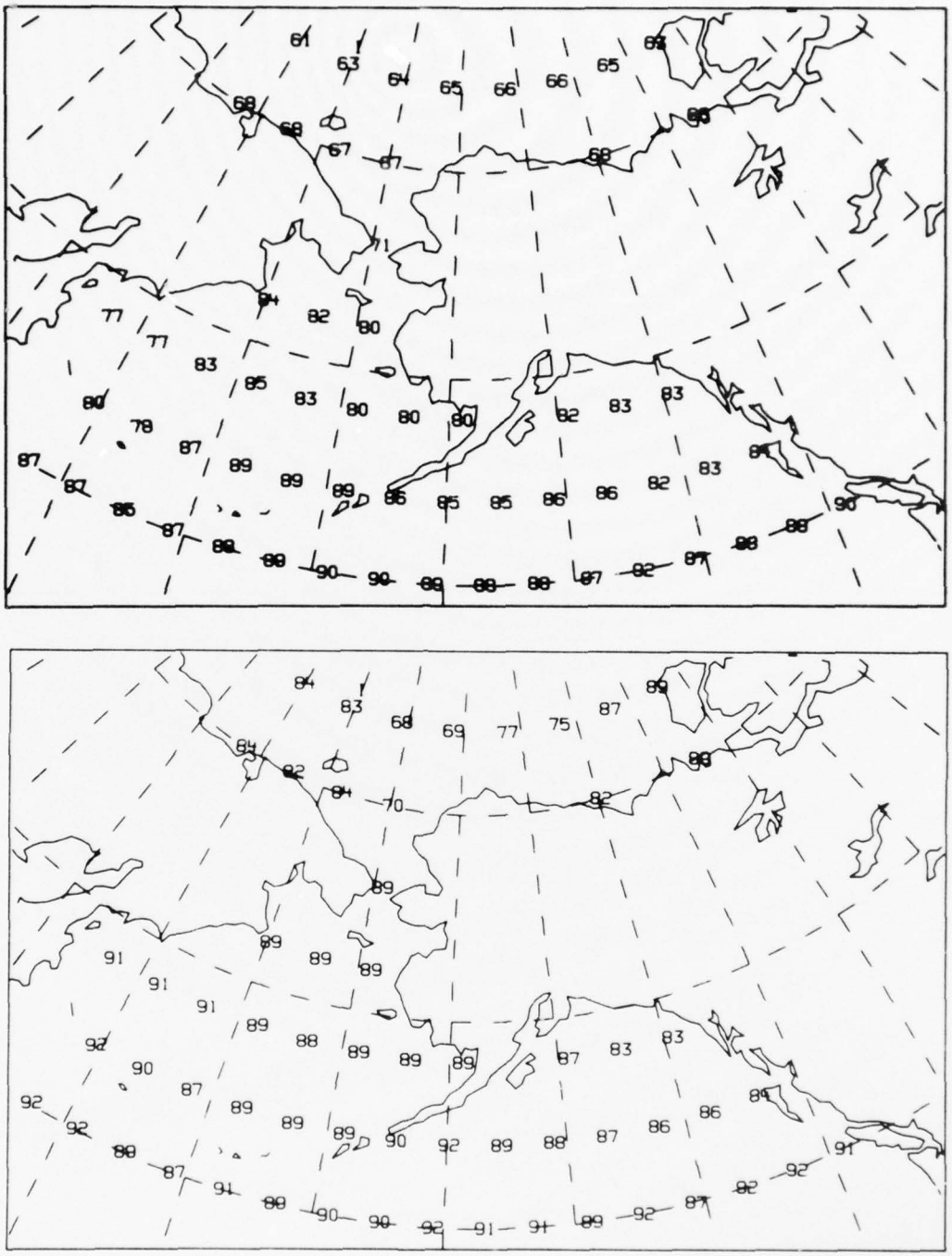

Figure 62. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 4, 6 and 8 MHz, summer night and low solar activity.

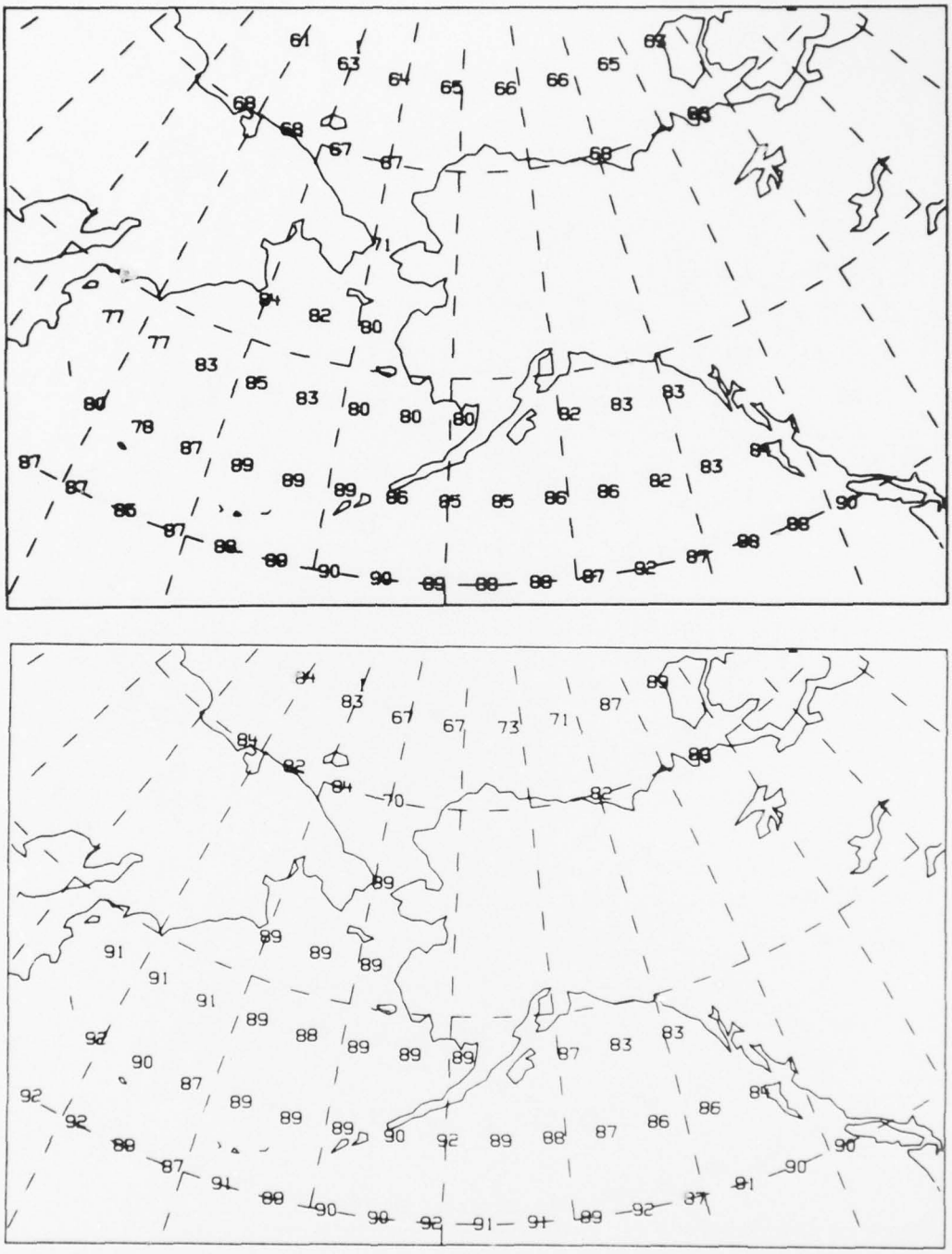

Figure 63. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 4 and 6 MHz, summer night and low solar activity.

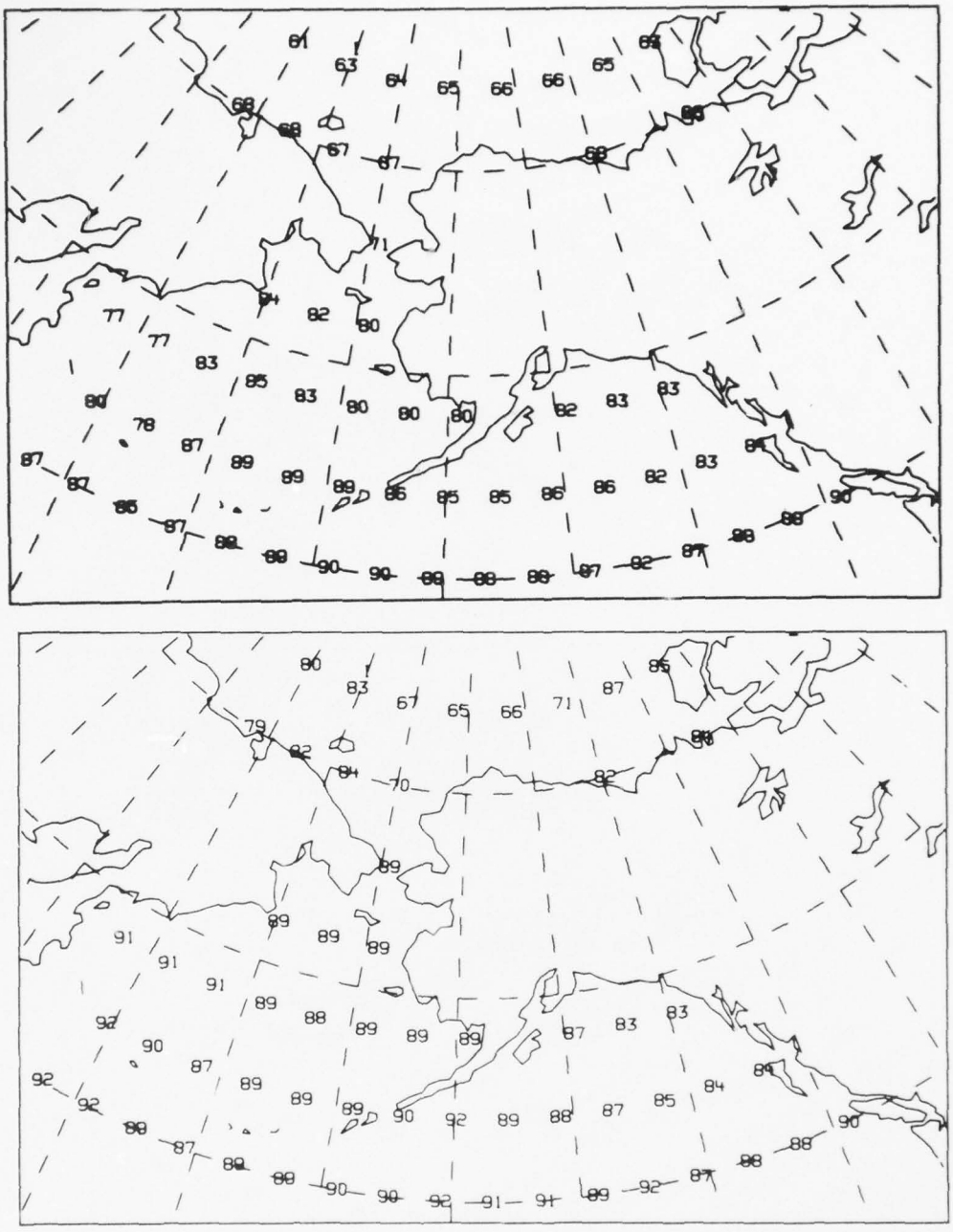

Figure 64. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 4 MHz, summer night and low solar activity.

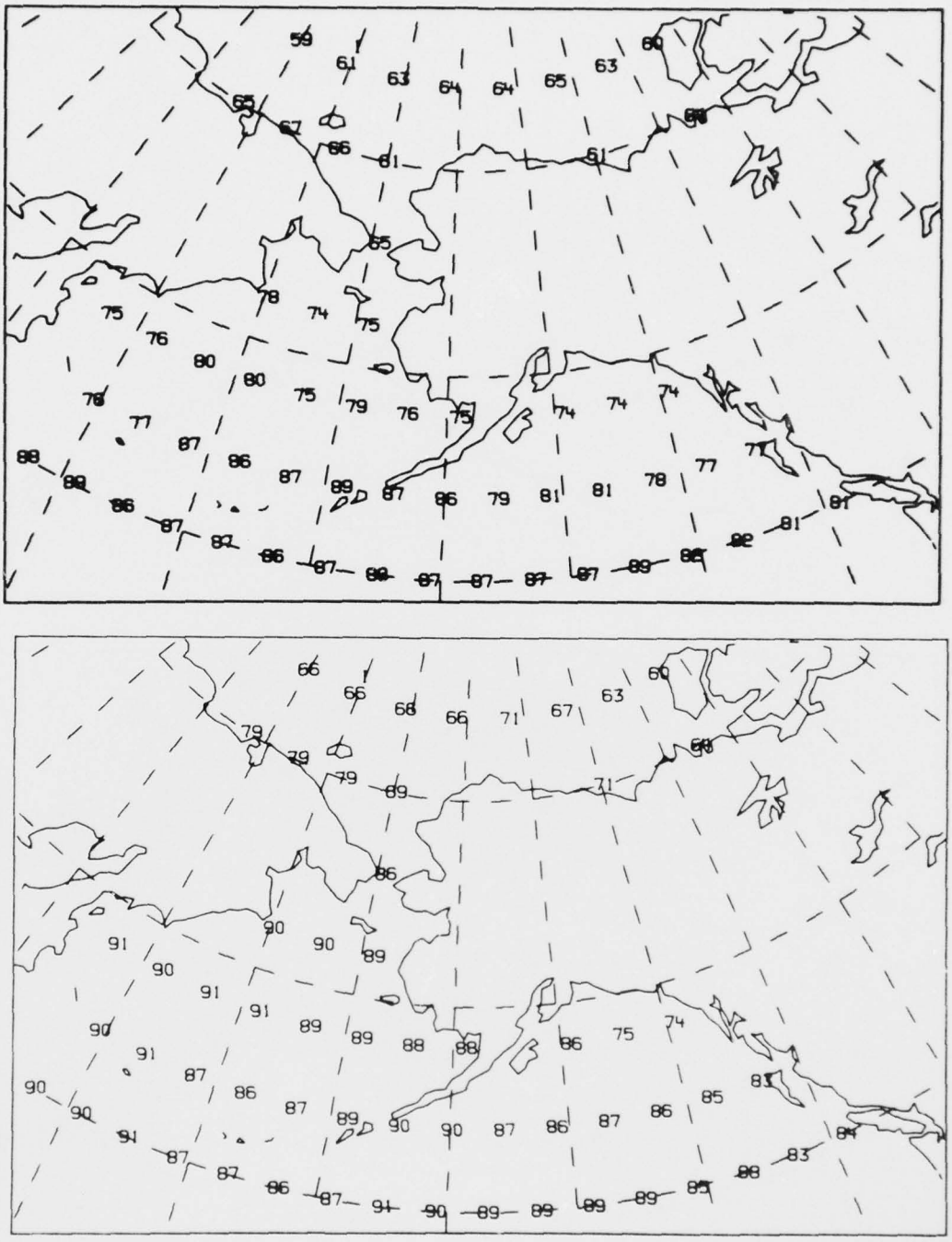

Figure 65. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak, 4, 6, and 8 MHz, summer night and high solar activity.

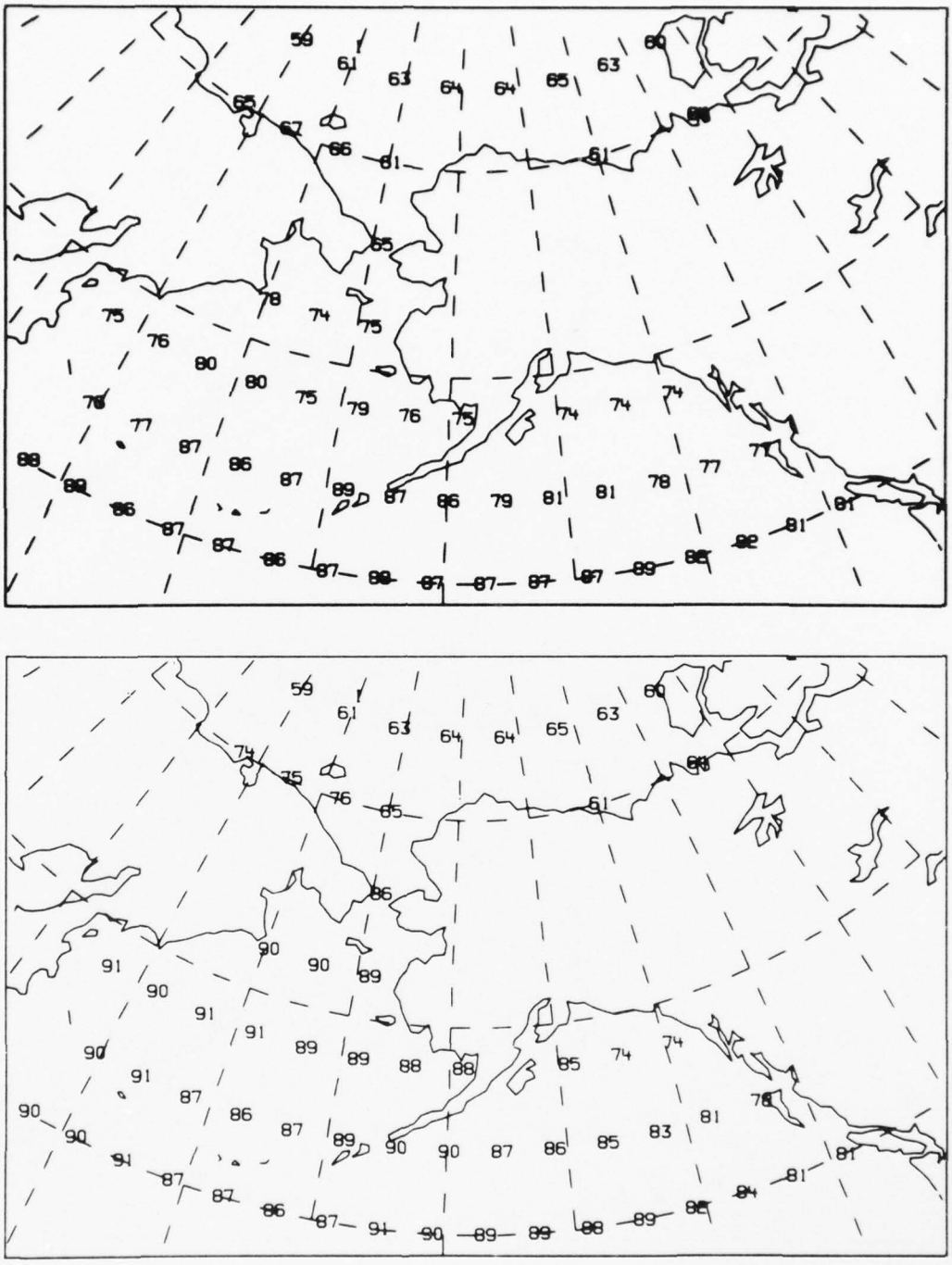

Figure 66. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak, 4 and 6 MHz, summer night and high solar activity.

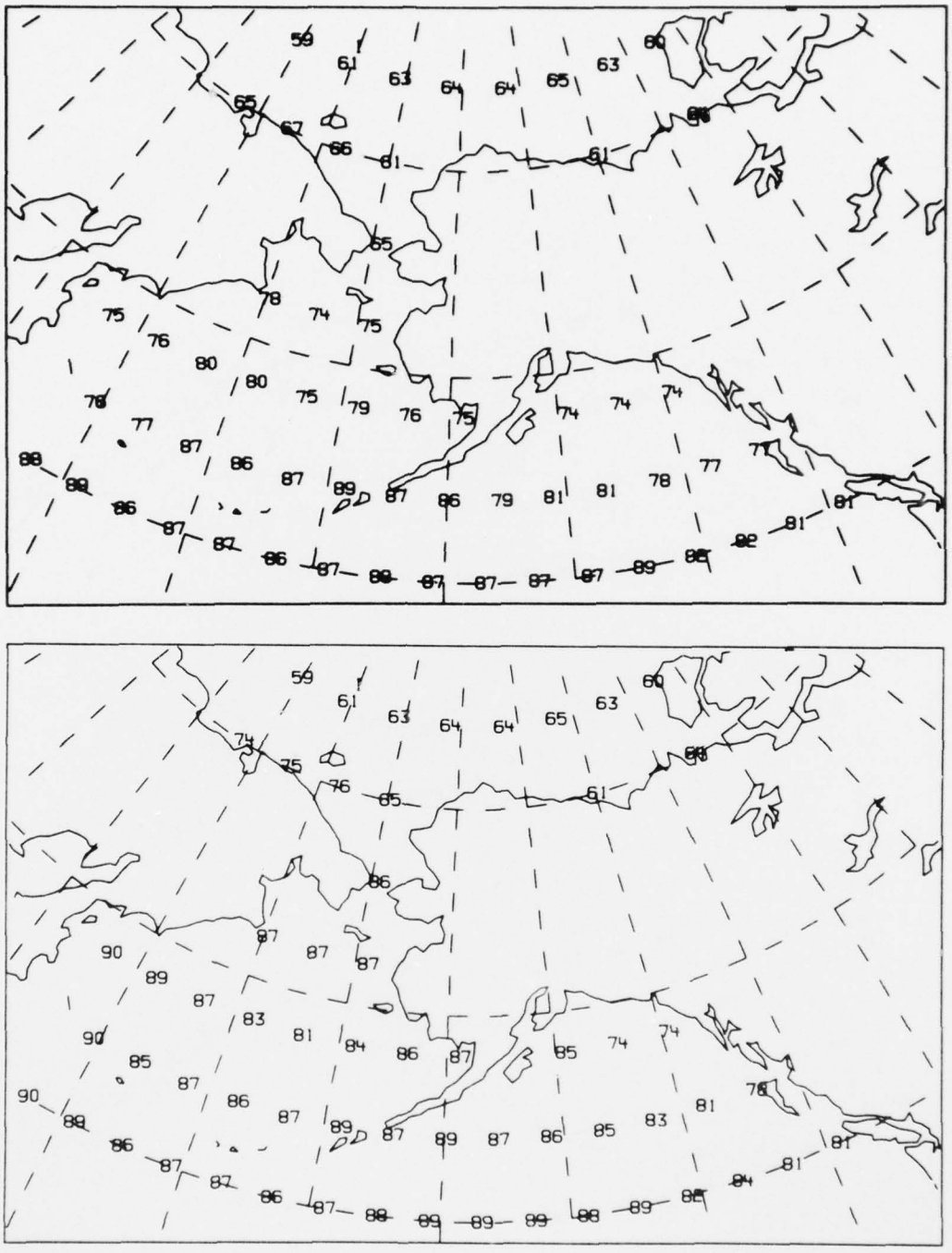

Figure 67. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Adak, 6 MHz, summer night and high solar activity.

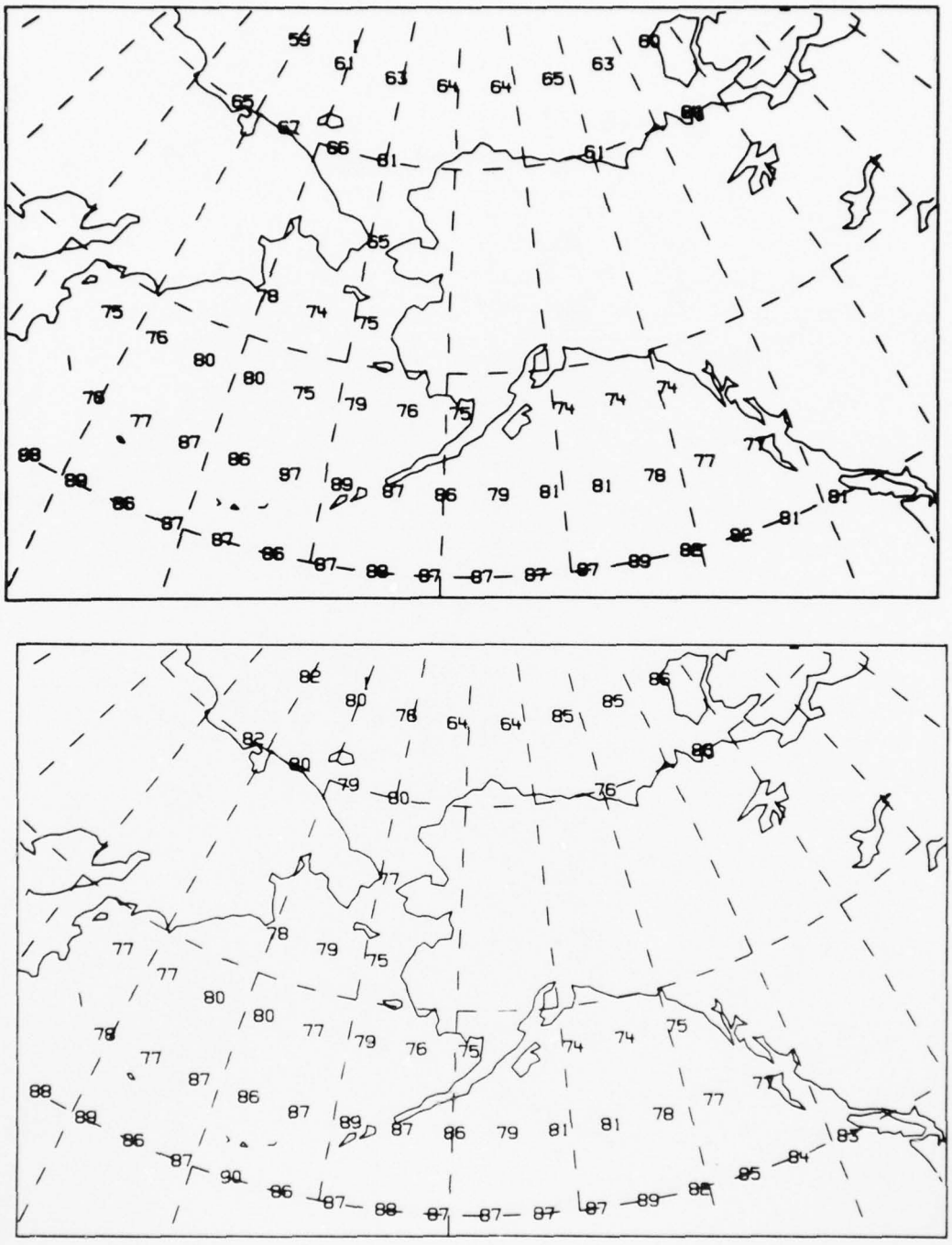

Figure 68. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 4, 6, and 8 MHz, summer night and high solar activity.

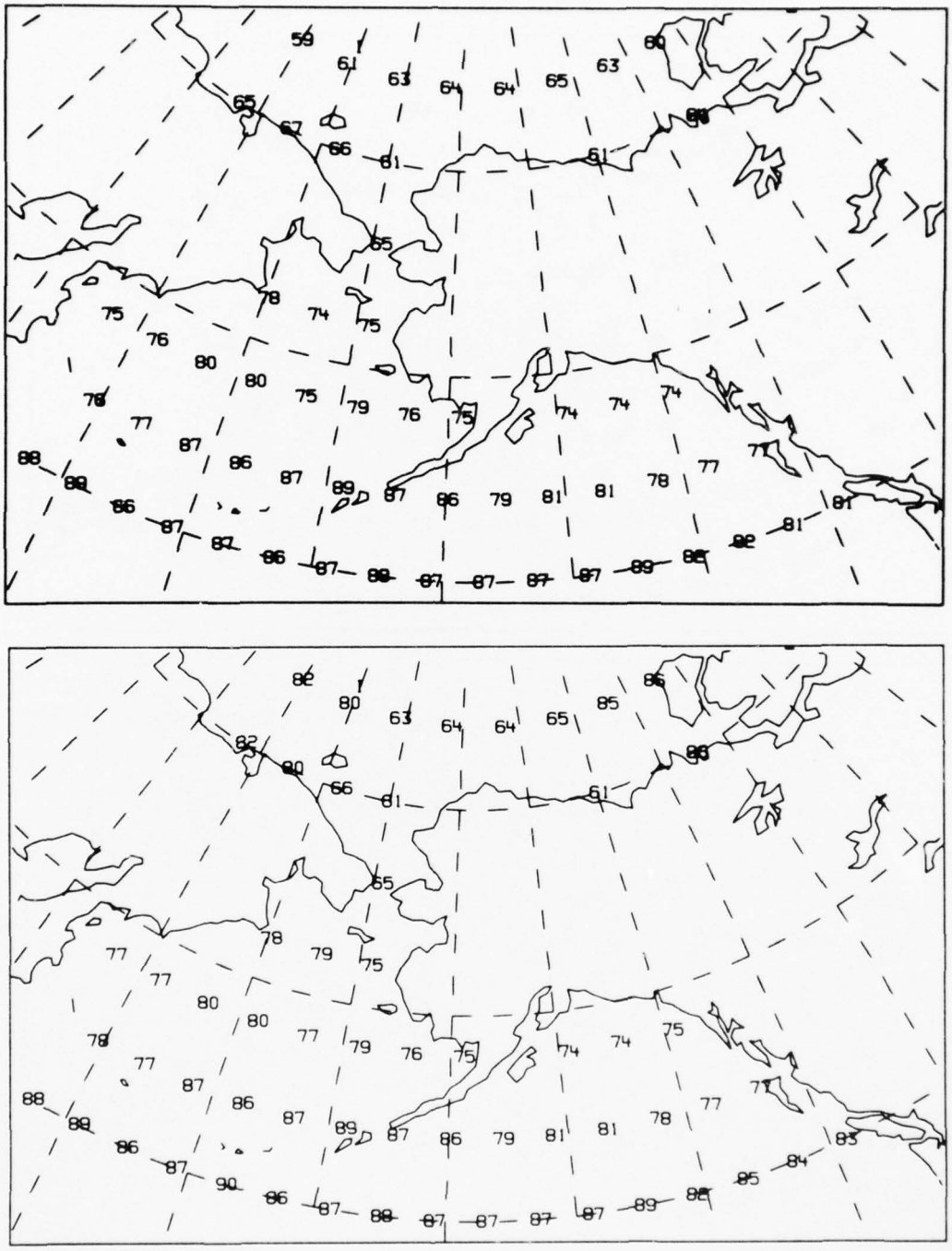

Figure 69. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 6 and 8 MHz, summer night and high solar activity.

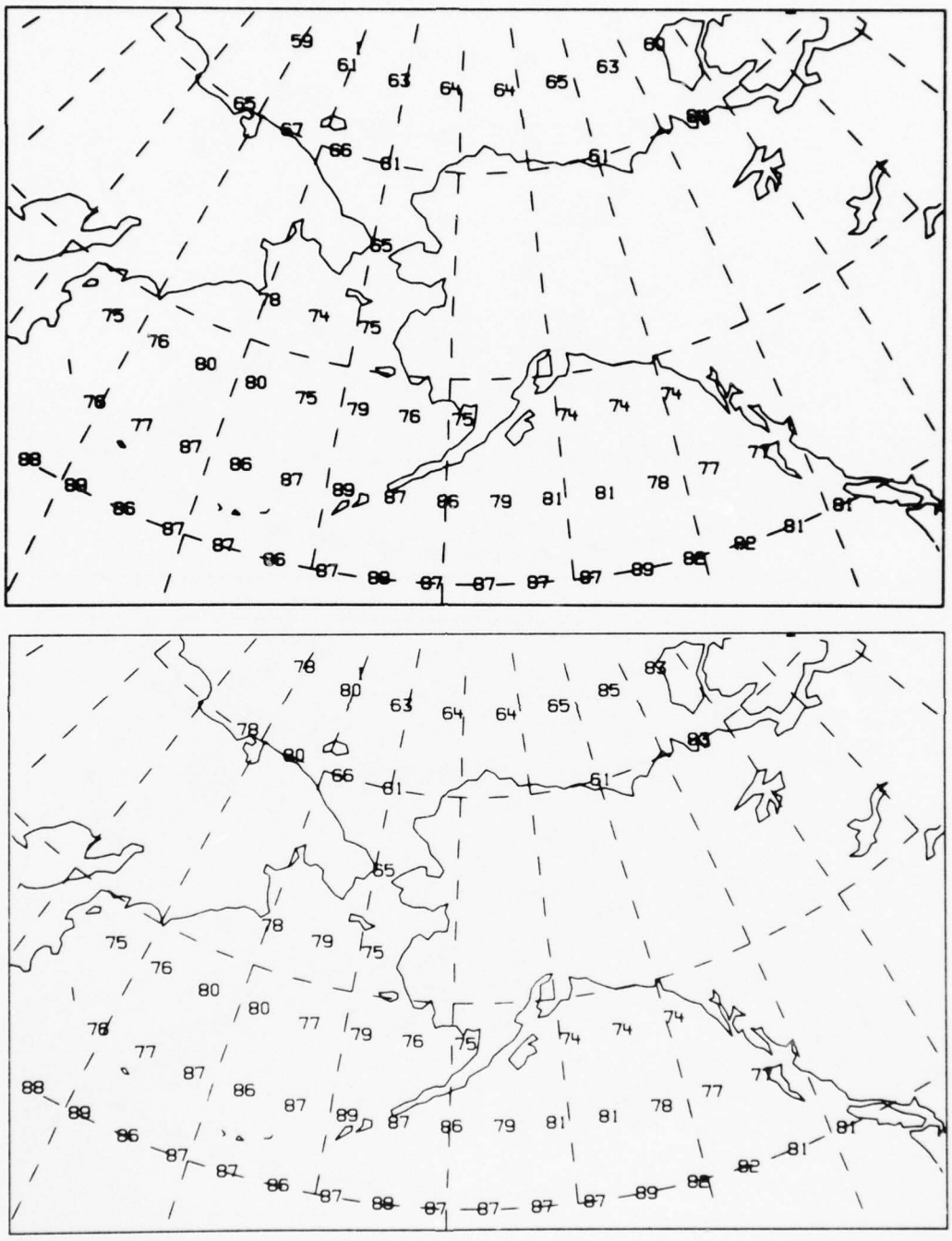

Figure 70. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional station - Barrow, 6 MHz, summer night and high solar activity.

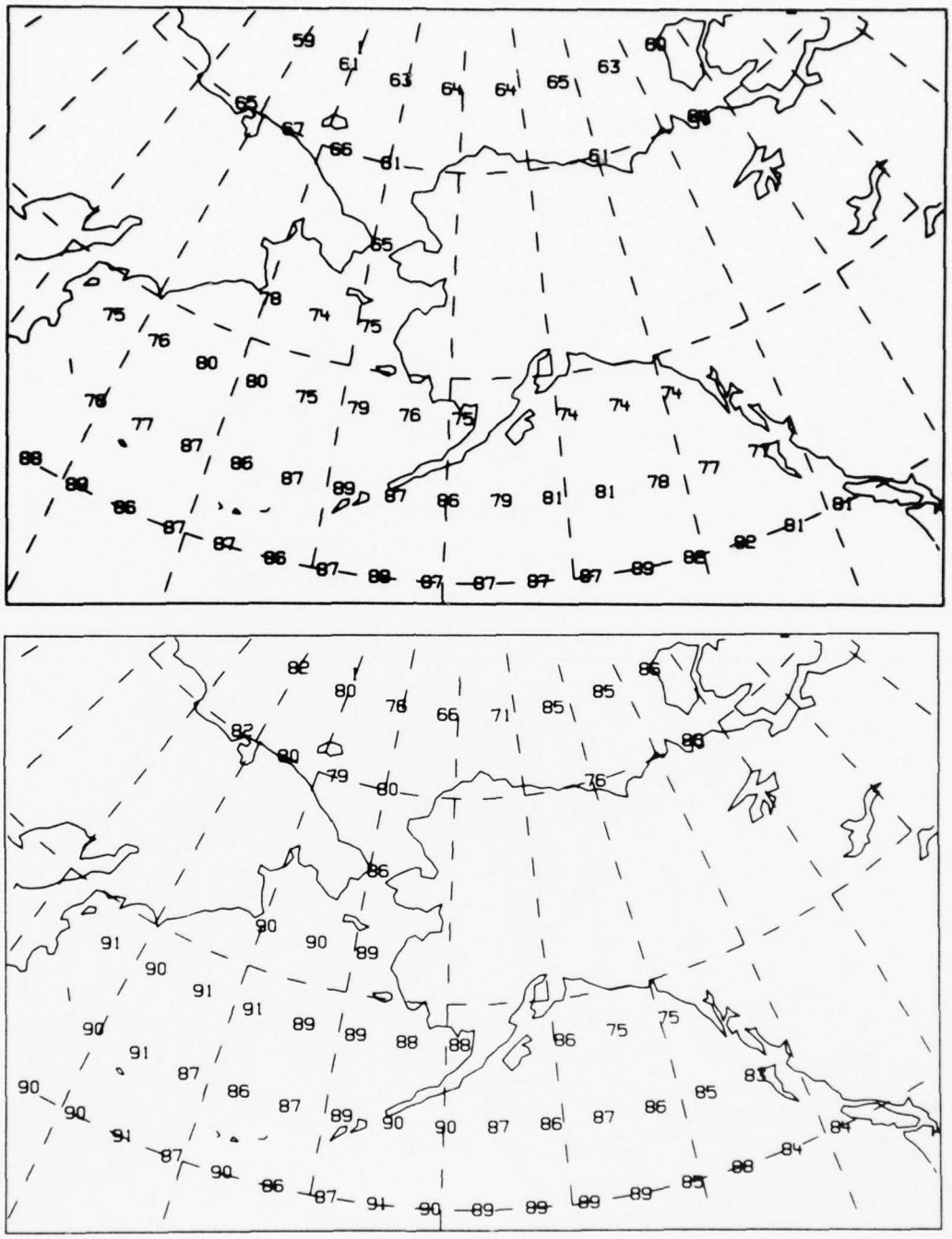

Figure 71. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 4, 6, and 8 MHz, summer night and high solar activity.

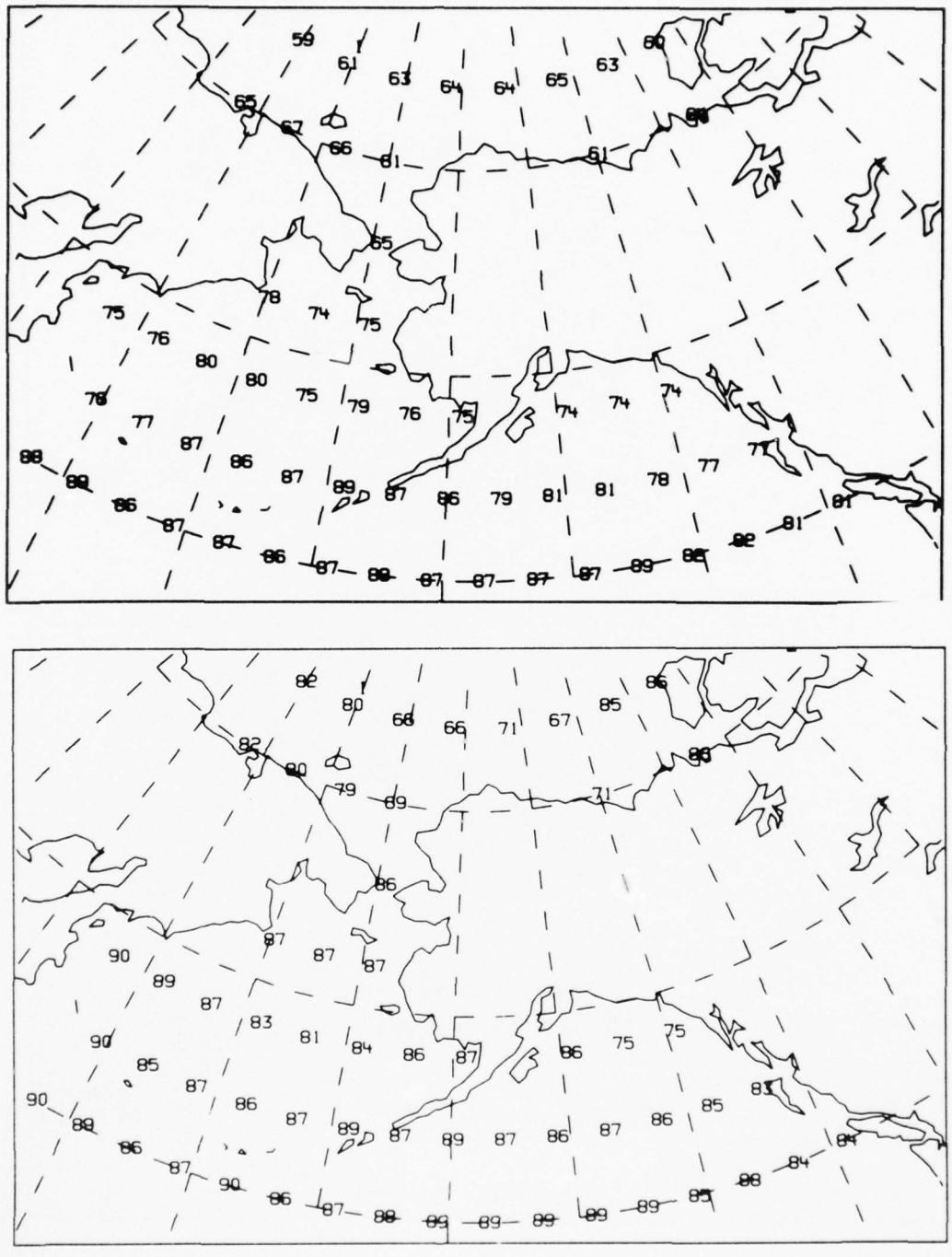

Figure 72. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 6 and 8 MHz, summer night and high solar activity.

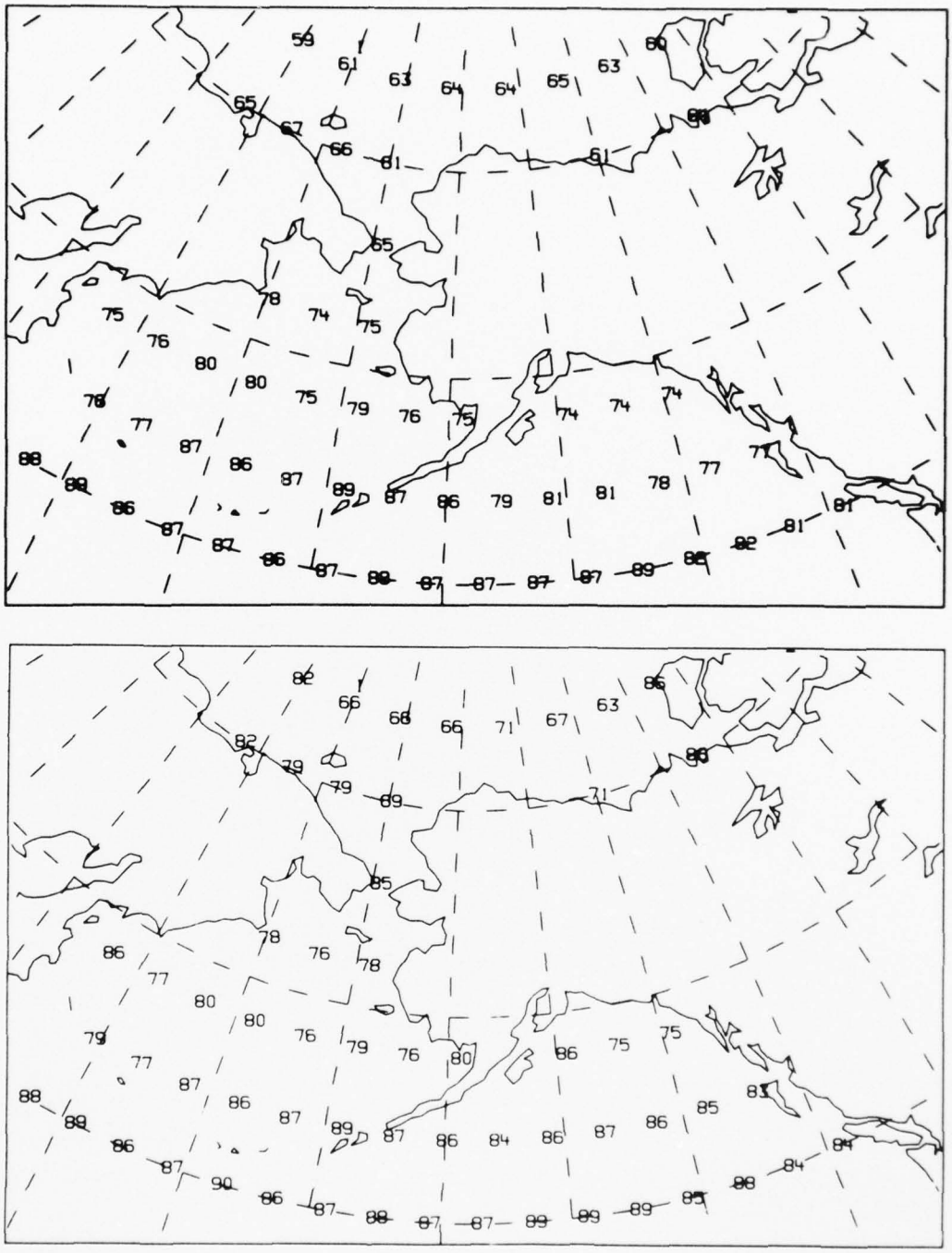

Figure 73. Base coverage reliability map (top) and coverage reliability map (bottom) for the following: additional stations - Adak and Barrow, 8 MHz, summer night and high solar activity.

APPENDIX

This is a collection of tables of the normalized weighted average (W_m) for the three available frequencies (in megahertz) for all seasonal, diurnal, and solar conditions and the various combinations of shore stations.

Additional Guards Established at		Adak		Barrow		Adak and Barrow	
		W_m	Freq.	W_m	Freq.	W_m	Freq.
Group	A	1.00	6	1.00	6	1.00	8
		0.97	8	0.94	8	0.83	6
		0.75	4	0.91	4	0.47	4
	B	1.00	8	1.00	8	1.00	8
		0.76	6	0.80	6	0.59	6
		0.46	4	0.67	4	0.32	4
	C	1.00	4	1.00	4	1.00	4
		0.65	6	0.75	6	0.57	6
		0.36	8	0.40	8	0.10	8
	D	1.00	4	1.00	4	1.00	4
		0.82	6	0.90	6	0.93	6
		0.60	8	0.70	8	0.42	8
	E	1.00	8	1.00	8	1.00	8
		0.65	6	0.55	6	0.54	6
		0.37	4	0.30	4	0.28	4
	F	1.00	8	1.00	8	1.00	8
		0.64	6	0.45	6	0.62	6
		0.16	4	0.22	4	0.19	4
	G	1.00	4	1.00	4	1.00	4
		0.83	6	0.93	6	0.97	6
		0.61	8	0.73	8	0.43	8
	H	1.00	6	1.00	6	1.00	8
		0.92	4	0.96	8	0.99	6
		0.91	8	0.90	4	0.75	4

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15. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

This work presents a study of the HF communication reliability of the high-frequency SSB small craft communication system for the Alaskan waters. Reliabilities are calculated assuming ionospheric propagation from a number of simulated ship positions (SSP's) in the waters bounded by 50° N. to 75° N. and 125° W. to 170° E. to three existing shore stations (San Francisco, Honolulu, Kodiak) on three maritime frequency bands (represented by 4, 6, and 8 MHz). These calculations are used to produce "base" coverage reliability maps for the following conditions: winter or summer, night or day, and high or low solar activity. It has been proposed to add one or two new shore stations at Adak or Barrow or both. The coverage reliability realized by adding either or both of these stations using all three frequencies is calculated. The best two and the best single frequency are then chosen for the added station(s) and the reliabilities are again calculated including either or both of the proposed stations.

16. Key works *(Alphabetical order, separated by semicolons)*
Alaskan waters; communications; HF; merchant vessels; reliability; SSB.

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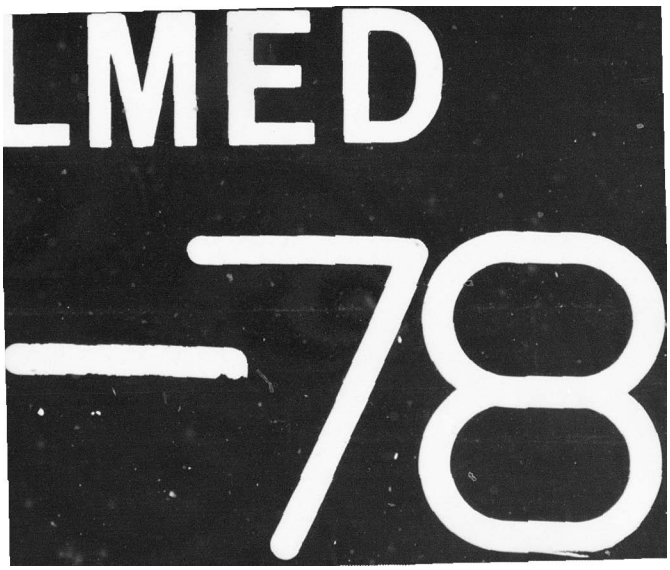
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